A Study of the Impact of Economics Education on Financial Risk Aversion

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Abstract

This paper seeks to study the effect of education in an economics-related field on financial risk tolerance and investigate potential drivers related to this effect. The study does find an estimate suggesting that economists invest 24 percentage points more of their liquid assets in stocks, but the coefficient is statistically insignificant. An analysis of the age patterns of economists and non-economists, respectively, reveals that for both groups, risk tolerance increases with age until the age of 52 and then decreases moderately until retirement. The results suggest that stock market experience is the main driver behind the increase in risk tolerance, while the decrease in the number of remaining pay checks in the main driver behind the subsequent decrease in risk tolerance. In addition, overconfidence, stock market experience, and the number of remaining pay checks are found to be more important in determining financial risk tolerance than financial literacy and analytical abilities. The study concludes that no significant difference is to be found between economists and non-economists. However, economists are found to be more likely to participate in the stock market.

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Introduction

In a recent study by Zhou (2013), students majoring in economics are found to be more risk tolerant than non-economics majors. In particular, the study finds that taking up classes in economics increases risk tolerance for non-economics students. This finding suggests that taking up classes in economics may alter your behaviour in various contexts. For example, you may accept more risky gambles or engage in more dangerous behaviour. In particular, a more risk tolerant person is expected to exhibit a higher degree of financial risk tolerance. This implies that they are likely to invest a larger proportion of their wealth in risky assets such as stocks rather than safe assets such as bonds.

In his mean-variance framework of 1952, Markowitz presented a theory on how investors should allocate their wealth between risky assets and risk-free assets. One important result of the framework is that investors face a trade-off between risk and return; that is, the higher return an investor demands from assets, the higher risk the investor must be willing to take up.

Mehra and Prescott (1985) present the equity premium puzzle, which refers to the empirical phenomenon that, even when considering the natural trade-off that exists between risk and return, stocks have historically outperformed bonds to such a degree that even highly risk-averse investors should prefer stock over bonds.

If economists do, in fact, exhibit a higher degree of financial risk tolerance and thus invest relatively more in stocks, they may also enjoy the benefits of earning a higher return than other investors.

The notion that economists are more risk tolerant than other groups is supported by several studies, pointing out analytical abilities and financial literacy as drivers for lower perceived risk, thus motivating them to take on more risk due to their confidence in being able to handle the complexity of investing in risky assets (Bajo et al., 2015; Shavit et al. 2016).

In spite of this potential difference between economists and those without economic background, it seems that little attention has been given to educating the general public in simple concepts of economics and finance. In particular, it is possible to take courses in personal finance in US high school, however not mandatory (CEE, 2016).

Motivated by the literature, this study will investigate the differences in risk tolerance between stock market participants with an educational background of economics or finance and stock market participants with non-economic background over their lifecycle, seeking to disentangle potential differences and determine possible drivers of the observed patterns.

Consistently higher investment in risky assets over their lifecycle among economists would suggest that economists' higher level of financial literacy and analytical abilities would cause them to take on more risk, potentially leaving those with little knowledge of finance in the dust. Should this be the case, it should motivate decision makers to educate people in economics, potentially reducing their perceived risk and thus causing them to earn greater returns on their savings.

Basing this study on observational data, we will measure risk tolerance as the extent to which stock market participants invest their liquid assets into stocks. We will throughout the literature review refer to risk aversion rather than risk tolerance as the literature mainly focuses on this measure.

Research question

The purpose of this paper is to answer the following research question:

Does economic or financial educational background affect the risk tolerance of households in investing? If so, what might be potential drivers of this difference?

To properly investigate this question, it will be divided into several sub-questions, investigating:

- What is the effect of age on risk tolerance?
- What is the effect of having economic or financial educational background on the level of risk tolerance?
- How do individuals with economic or financial backgrounds' risk tolerance develop with age, relative to those without economic or financial background?

Additionally, the results from the core questions will be backed by analysis and discussion of:

- The effect of income, educational level, and housing ownership on stock investments
- The effect on risk tolerance of having a quantitative, non-economics education
- The effect of self-selection on stock market participation

Literature Review

This section will review the most basic theory and empirical findings relevant for the purpose of the paper, looking into utility theory, risk aversion as well as relevant behavioural theories and findings that may contribute to the study.

Defining Risk Aversion in an Economic Context

Utility Theory

Initially presented by von Neumann and Morgenstern (1944), the most fundamental result within decision and game theory is the von Neumann-Morgenstern expected utility theorem, which also provides the basis for most recent economic theory. Von Neumann and Morgenstern develop their utility concept based on a set of axioms: completeness, transitivity, continuity and independence/irrelevance.

Completeness refers to completeness of the system of individual preferences; that is, the preferences of the individual are well-defined and only one of the three following hold for alternatives, A and B:

$$A \succ B, \qquad A \prec B, \qquad A \sim B$$

Either, the individual prefers A to B, B to A or is indifferent between the two.

The second axiom, transitivity, implies that if $A \succ B$ and $B \succ C$, then $A \succ C$. That is, individuals are consistent in their rankings of alternatives.

The continuity axiom states that for $A \succ B \succ C$, a probability $p \in [0, 1]$ exists such that

$$pA + (1 - p)C \ \sim \ B$$

Thus, for mutually exclusive events A and C where A is strictly preferred to C, it is always possible to find a probability such that the individual is indifferent between B and a lottery where the outcome is A with probability p and C with probability $(1 - p)$.

Finally, independence or irrelevance implies that if an individual prefers A to B, when a third independent or irrelevant option, C is offered, it will not change the ordering of preferences with respect to A and B. Formally, if $A \succ B$,

$$pA + (1 - p)C \ \succ \ pB + (1 - p)C$$

Given these four axioms, von Neumann and Morgenstern derived the theorem which states that for any two lotteries, L and L',

$$E[u(L)] \geq E[u(L')] \; if \; and \; only \; if \; L \succ L'$$

where $E[u(L)]$ is the expected utility of lottery L over all n possible states of the lottery:

$$E[u(L)] = p_1 u(L_1) + . . . + p_n u(L_n)$$

In the framework of expected utility theory, risk aversion is defined as preferences such that the individual is never willing to accept a fair lottery, i.e. a lottery with an expected payoff of 0. For an individual with initial wealth w, this implies that the expected utility of accepting a gamble, $\tilde{\varepsilon}$, with $\tilde{\varepsilon} = p\varepsilon_1 + (1-p)\varepsilon_2$ and $E[\tilde{\varepsilon}] = 0$ is lower than the certain utility of rejecting the gamble:

$$E[u(w + \tilde{\varepsilon})] < u(w)$$

An important implication of the expected utility theorem is that an individual can be risk-averse if and only if the utility function is concave, or equivalently, for a risk-averse individual, the utility of the expected value of a gamble with uncertainty is always higher than the expected value of the utilities under each state. It follows that a risk-averse individual is always willing to pay a positive amount in order to avoid such a gamble. The risk premium, π, is the maximum amount that the individual is willing to pay to avoid the gamble and is defined by the condition that the expected utility of accepting the gamble must be equal to the certain utility of rejecting the gamble and losing a positive amount of π:

$$E[u(w + \tilde{\varepsilon})] = u(w - \pi)$$

The more risk aversion an individual exhibits, the higher the risk premium must be. This suggests that the concept of risk aversion is related to the curvature of the utility function.

Utility-Based Risk Aversion Measures

Building on expected utility theory, Arrow (1965) and Pratt (1964) have become widely known for their measures of risk aversion, more specifically known as the Arrow-Pratt measures of risk aversion. For a utility function of wealth, $u(w)$, they define the absolute risk aversion (ARA) as the negative of the ratio between the second and the first derivative of the utility function:

$$A(w) = -\frac{u''(w)}{u'(w)}$$

Since the risk premium and thus the risk aversion of an individual is determined by the curvature the individual’s utility function, the absolute risk aversion measure simply evaluates the curvature of the function and scales it by the first derivative of the utility function with respect to wealth in order for the measure to be robust to affine transformations of the utility function. For small gambles, it can be shown that

$$\pi \cong -\frac{1}{2}\sigma^2\frac{u''(w)}{u'(w)} = \frac{1}{2}\sigma^2 A(w)$$

where σ^2 is the variance of the gamble payoff, $\tilde{\varepsilon}$. This demonstrates how the absolute risk aversion measure is proportional to the risk premium.

Arrow and Pratt also suggested a relative risk aversion measure, which is simply defined as the product of the absolute risk aversion coefficient and wealth:

$$R(w) = wA(w) = -\frac{wu''(w)}{u'(w)}$$

Whereas absolute risk aversion relates risk aversion to the absolute value of the risk premium, relative risk aversion relates to the relative value of the risk premium with respect to wealth. In a gamble where the risk is proportional to wealth, $w + w\tilde{\varepsilon}$, and $\pi = \theta w$, it can be shown that

$$\theta \cong \frac{1}{2}\sigma^2 R(w)$$

An individual exhibits constant absolute risk aversion (CARA) utility if the absolute risk aversion coefficient is independent of wealth, $A(w) = c$. In this case, increasing the individual’s wealth has no effect on the risk premium. Constant relative risk aversion (CRRA), on the other hand, suggests that the relative risk aversion coefficient is constant, $R(w) = C$, which implies decreasing absolute risk aversion since $A(w) = \frac{R(w)}{w}$. In this case, the importance of the risk imposed by a certain gamble diminishes as wealth increases. For investments, the implications of CARA and CRRA are that an investor with CARA utility always will invest the same dollar amount in risky assets regardless of the development in their wealth, while an investor with CRRA utility will hold the same percentage of wealth in risky assets.

Theoretical Frameworks of Risk Aversion in Investments

Portfolio Choice Models

The asset pricing literature presents an approach to analysing the relationship between risk aversion and investment behaviour largely based on utility theory and the related measures of risk aversion. Portfolio choice models seek to derive expressions that describe the optimal investment behaviour given a number of determinants. From these, risk aversion coefficients may be backed out if information on the remaining variables is obtainable. A simple model (Arrow, 1965 in Back, 2010) consists of two periods and n assets; in the first period, the investor invests his total wealth, w_0, in all n assets by purchasing θ_i number of shares of asset i at a price p_i per share. In the second period, the investor gets a stochastic payoff, $\tilde{x}_i$, from each share of asset i owned, resulting in a total wealth of $\widetilde{w}$. The investor seeks to create the portfolio that maximizes expected utility of the total wealth obtained in the second period:

$$\max_{(\theta_1,\ldots,\theta_n)} E[u(\widetilde{w})]$$

$$subject\ to\ \sum_{i=1}^{n} \theta_i p_i = w_0 \quad and\ \widetilde{w} = \sum_{i=1}^{n} \theta_i \tilde{x}_i$$

Solving this optimization problem by the Lagrangean yields the following first-order condition:

$$E[u'(\widetilde{w})\tilde{x}_i] - \gamma p_i = 0,$$

where γ is the Lagrange multiplier. Defining $\tilde{R}_i \equiv \tilde{x}_i / p_i$ as the gross return on asset i, the first-order condition can be rewritten as

$$E\left[u'(\widetilde{w})\left(\tilde{R}_i - \tilde{R}_j\right)\right] = 0$$

The condition states that, in optimum, the expected marginal value of shifting investments from one asset to another must be equal to 0. Intuitively, the portfolio would not be optimal if additional value could be obtained by shifting current investments. In the special case of one risky asset that pays out a stochastic gross return of $\tilde{R}$ and one risk-free asset that pays out a gross return of R_f with certainty, the first-order condition can be written as

$$E\left[u'(\widetilde{w})\left(\tilde{R} - R_f\right)\right] = 0$$

A consequence of this condition is that it cannot be optimal for the investor to invest the total amount of wealth in the risk-free asset if the risk premium, $E\left[\tilde{R} - \tilde{R}_f\right]$, is positive. This is the case since investing the total amount of wealth in the risk-free asset would make $\widetilde{w}$ deterministic, such that the condition can be written as

$$u'(\widetilde{w})E\left[\left(\tilde{R} - R_f\right)\right] = 0$$

If the risk premium, however, is positive, this expression can never be 0 as the utility function is assumed to be concave and increasing in wealth, implying that the first derivative of the utility function must be positive. Thus, a positive risk premium implies positive investments in the risky asset.

By assuming a functional form of the utility function, explicit expressions can in certain cases be derived for the optimal portfolio choice. The exponential function is often used to model CARA utility. By letting $u(\widetilde{w}) = -e^{-c\widetilde{w}}$, where $A(w) = c$, and assuming normally distributed returns, the following optimality condition can be derived:

$$\phi = \frac{\mu - R_f}{c\sigma^2}$$

where ϕ is the optimal amount to invest in the risky asset, μ is the mean return of the risky asset, and σ^2 is the return variance of the risky asset. Thus, the model predicts that the optimal investment in the risky asset is increasing in the risk premium, $\left(\mu - R_f\right)$, decreasing in the variance, σ^2, and decreasing in absolute risk aversion, c. Investors with high degrees of risk aversion are thus expected to invest smaller amounts in the risky asset, while investors with low degrees of risk aversion are expected to invest larger amounts in the risky asset. Since risk aversion was assumed to be independent of wealth in this example, the optimal amount to invest in the risky asset does not depend on wealth. A similar approach, however, can be taken in order to derive explicit results for CRRA utility, in which case the optimal amount invested in the risky asset will increase in wealth.

Modern Portfolio Theory

Markowitz's (1952) mean-variance analysis presents a slightly different perspective on analysing the link between risk aversion and investment behaviour. In this framework, it is suggested that the main determinants of the individual's investment decision are the two moments of the stock returns, mean and variance. The intuition behind this is that a higher mean is desirable as investors prefer a higher stock return, while a higher variance is undesirable for the risk adverse investor since it implies higher volatility. The investor must thus face a trade-off between risk and return.

The investor is able to invest in n different assets with positive returns, $\bar{R}_i > 0$, and positive volatility, $\sigma_i > 0$, with which customized portfolios can be created by assigning weights, w_i, to each asset. The optimal portfolio choice is derived by assuming that the investor based on individual preferences chooses a target level of return, μ_p, and minimizes the portfolio variance given that the expected portfolio return is μ_p and the sum of weights add up to 1:

$$\min_{(w_1,\dots,w_n)} \quad \frac{1}{2}\sum_{i=1}^{n}\sum_{j=1}^{n} w_i w_j \sigma_{i,j}$$

$$subject\ to \quad \sum_{i=1}^{n} w_i \bar{R}_i = \mu_p \quad and \quad \sum_{i=1}^{n} w_i = 1$$

Solving the quadratic optimization problem yields the optimal portfolio choice given μ_p. The set of all such solutions to the problem constitutes the efficient frontier. Since these portfolios are the least risky given their level of return, they must be preferred to all other portfolios regardless of the investor's preferences.

When allowing for investment in a risk-free asset which pays out the risk-free rate, R_f with certainty and thus has a volatility parameter, σ_f, of 0, all portfolios on the efficient frontier but one become dominated by linear combinations of the risk-free asset and the tangency portfolio. This implies that the tangency portfolio must be a portfolio of all market assets as it is the only portfolio of the market assets that investors are willing to hold. It is hence referred to as the market portfolio. The investor's portfolio choice thus reduces to deciding upon the weight of the total wealth invested in the market portfolio, as the remaining wealth is invested in the risk-free asset. Since the market portfolio on average pays out the market rate, $\bar{R}$, where $\bar{R} > R_f$, a higher weight in the market portfolio is associated with a higher expected return, but a higher level of risk also. This implies that investors with high degrees of risk aversion are expected to invest a relatively small proportion of their wealth in the market while investors with low degrees of risk aversion invest a relatively high proportion. Although Markowitz's approach differs slightly from the utility-based approach, it can be shown that the assumption that investors consider only the mean and variance of the returns holds true only if investors have quadratic utility functions or if returns are elliptically distributed.

Determinants of risk aversion

Theoretically, and empirically, several characteristics of households and individuals are proposed and found to be relevant for an individual's degree of risk aversion. In this section, the most essential findings on the determinants of risk aversion will be covered. It will cover, respectively, the effects of income/wealth, age, complexity of the problem, educational background, and other demographic characteristics, including gender, marital status and religious beliefs.

Income and wealth

Eeckhoudt, Gollier and Schleslinger (2005) state that there are no clear arguments for or against decreasing relative risk aversion, although Arrow originally conjectured that relative risk aversion is likely to be constant, which is also a widely-used assumption in economics. However, the empirical results are often contradicting.

Morin and Suarez (1983) generally find decreasing relative risk aversion (DRRA) in household portfolios. This finding is supported by Riley and Chow (1992), who find that risk aversion decreases after one passes the poverty level, and when reaching the top 10% of wealth, risk aversion decreases greatly. However, Morin and Suarez (1983) also find that for lower wealth households, there is increasing relative risk aversion (IRRA), which is also confirmed by Siegel and Hoban (1982). West and Worthington (2013) argue, in line with these studies, that there appear to be behavioural differences in the tails of the wealth distributions. While households with low wealth are more reluctant to take on risk, those with very high wealth are less risk-averse.

While the studies above find relative risk aversion to be either increasing or decreasing, Friend and Blume (1975) found it to be constant, thus concluding that wealth has an insignificant effect on households' relative allocation of wealth into risky assets. Thus, the findings of whether income and/or wealth impact households' (or individuals') relative investment in risky assets are often contradictory, and no clear conclusions about these relationships can be drawn based on the literature.

Age

The literature offers a number of perspectives on how and why risk aversion might change with age. First, behavioural studies typically find that individuals in the early stages of their life are more likely to exhibit low levels of risk aversion due to developmental, biological, and environmental factors (Igra and Irwin, 1996; Rubin and Paul, 1979). Related to this proposition, Sapienza, Zingales and Maestripieri (2009) argue that as a higher level of testosterone is associated with a lower degree of risk aversion and the level of testosterone for both genders typically decreases with age, a positive effect of age on risk aversion is expected to be found. Albert and Duffy (2012) relate age and risk aversion through cognitive abilities, arguing that the decline of cognitive abilities with age increases risk aversion in decision-making. The studies confirm a generally positive relationship between age and risk aversion.

Concerning financial risk aversion specifically, a number of additional theories contribute to explaining the age effect of risk aversion. Building on utility theory, the Life Cycle Hypothesis (LCH), developed by Modigliani and Brumberg (1954), suggests that individuals try to smooth their consumption throughout the entire span of their life by building up assets during the early stages of their lives, which are later consumed after retirement. The Life Cycle Risk Aversion Hypothesis (LCRAH), developed by Bakshi and Chen (1994), builds on the LCH by proposing that when human capital, defined as the number of remaining pay checks, is an approximately decreasing function of age and when relative risk aversion decreases in human capital, then this should lead to increasing risk aversion with age. On the other hand, financial risk aversion may also be expected to decrease with age as individuals gain more experience with age, which, as a general rule, is expected to have negative effect on risk aversion (Graham et al., 1999).

Empirical results on age and investment behaviour include studies by Friend and Blume (1975) and Morin and Suarez (1983) who all find that risk aversion increases with age. Riley and Chow (1992), however, find that risk aversion decreases with age until age 65, after which it increases drastically. This behaviour seems consistent with the LCH and somewhat consistent with the LCRAH as investors appear to build up assets for later consumption, and human capital practically disappears after retirement.

Complexity

One of the main objections to utility theory is the result that the behaviour of individuals in reality often tends to be inconsistent with the independence axiom on which the theory is built. This result was studied by Allais (1953) and has since been referred to as the Allais paradox. Although the independence axiom has the appearance of being a quite rational decision rule, Allais demonstrated that individuals tend to violate it in their decision-making. In his experiment, Allais constructed the two lotteries A and B, which he asked the participants to choose between:

A: \$1 $million\ with\ prob$ 1

B: \$5 $milion\ with\ prob$ 0.10, \$1 $milion\ with\ prob$ 0.89, \$0 $with\ prob$ 0.01

In addition, the two lotteries C and D were constructed, between which the participants subsequently were asked to choose:

C: \$1 $million\ with\ prob$ 0.11, \$0 $with\ prob$ 0.89

D: \$5 $milion\ with\ prob$ 0.10, \$0 $with\ prob$ 0.90

Following the independence axiom, it can easily be shown that an individual with preferences $A \succ B$ must also have preferences $C \succ D$. Likewise, preferences $B \succ A$ should imply $D \succ C$. The results of the experiment, however, revealed that the majority of the participants reported that they preferred lottery A to B, but also that they preferred lottery D to C.

One possible explanation is the idea that individuals are not as rational as economic theory suggests. Simon (1955) proposed the concept of bounded rationality which suggests that individuals are only partly rational due to their cognitive limitations. Simon argued that economic agents switch to heuristics, or rules of thumb, rather than applying rigid rules of optimization when the issues in question increase in complexity. This suggests that the degree of complexity, or perceived complexity, of an issue may influence individuals' risk attitudes towards a given problem.

The idea that the complexity of an issue influences risk aversion supports the notion that experience may influence risk aversion. As an investor's experience with the stock market, for example, increases, the concept of trading stocks may appear less complex and thus decrease the given investor's risk aversion toward investing (Graham, 1999; Li, 2002; Boyson, 2003).

Another factor that could possibly reduce perceived complexity and thus risk aversion is the analytical or cognitive abilities of the individual. The literature finds that numeracy and general cognitive abilities tend to be related positively to financial outcomes and are highly correlated with financial literacy (Banks & Oldfield 2007; Gerardi et al. 2010). With respect to risk aversion, Dohmen et al. (2010) confirm a negative relationship as they find that individuals with high levels of cognitive abilities are less risk-averse and are less impatient than others are.

Educational Background

Of primary interest to our study is the link between education and risk aversion. A number of studies analyse the general effect of educational levels on risk aversion. Donkers, Melenberg, and Soest (2001) apply a semiparametric model to back out an index for risk aversion based on a survey covering questions on lotteries and find that individuals with higher levels of education tend to be less risk-averse. This result is supported by several studies (Riley and Chow, 1992; Hartog et al., 2002; Harrison et al., 2007).

A major issue in this regard, however, is that of reverse causality. Human capital theory suggests that education is a function of risk aversion; education is simply considered an investment which reduces risk and increases salary in the future in exchange for present earnings, and agents, in accordance with expected utility theory, maximize expected lifetime utility by choosing the educational level consistent with their risk attitudes (Goldthorpe, 1996; Morgan 1998). Jung (2015) approaches this problem by studying a natural experiment – the British education reform of 1972. By arguing that changes in risk aversion following this reform, which increased the duration of compulsory schooling by one year, must primarily be a result of changes in education, Jung finds that one year of additional schooling has a positive effect on risk aversion and that the effect is particularly strong for individuals with low levels of education. Hersch (1996) finds a similar positive relationship between education and risk aversion when studying safety choices such as smoking and wearing seat belts.

The issue of educational level is closely related to parental education and socioeconomic status. Using a survey and confirming the results in an experiment, Dohmen et al. (2011) find that parental education levels are associated with higher willingness to take risks. In particular, father's education has a positive impact on risk taking in all measured contexts, while mother's education is relevant for risk taking in sports, leisure, and career.

Zhou (2013) suggests that, in addition to the level of education, the field of education may also serve as a potential determinant of individuals' risk attitudes. Specifically, Zhou studies the risk preferences of college students majoring in economics compared to students of non-economics fields. In general, the literature tends to focus on risk aversion as a determinant of choice of educational field. Klijn, Pais, and Vorsatz (2013) study how risk aversion may influence school choice and find that risk-averse individuals in general apply more protective strategies and try to minimize the potential downside of their payoffs. De Paola and Gioia (2012) further show that more risk-averse students are more likely to choose any other field than social sciences as a major. They suggest that engineering and natural sciences are preferred due to the lower risk in the labour market, while Humanities are preferred due to the lower risk of dropping out.

The experimental literature does find that economics majors do, in fact, differ from non-economics majors on several personality characteristics but attribute these differences primarily to self-selection. Carter and Irons (1991) conclude that economics students tend to be more selfish, while Marwell and Ames (1981) show that they are more likely to free-ride than non-economics students. Bauman and Rose (2009), however, do find that contributions to social programs are significantly lower amongst economics students than non-economics students due to self-selection, but they conclude that the result is also partly attributable to an "indoctrination effect". Similarly, Zhou (2013) attempts to disentangle the indoctrination effect from the self-selection effect with respect to risk aversion. Using data from a survey on gambling experiments performed on college students, Zhou separates the two effects by studying the change in behaviour as an increasing number of economics classes are completed amongst both economics majors and non-economics majors. The study concludes that economics students in general do exhibit less risk-averse behaviour, which is mainly due to self-selection, but that the risk aversion of non-economics students who take a single or few introductory courses in economics is affected negatively.

In relation to investment behaviour, Bajo, Barbi, and Sandri (2015) extend the result by concluding that a degree in economics or finance as a determinant of risk aversion with respect to investment behaviour has a significantly negative effect, arguing that economics education increases financial literacy, which in turn decreases perceived risk and thus risk aversion. The argument that financial risk aversion is reduced as financial literacy is increased is consistent with the idea that complexity is a central determinant of risk aversion; as investors learn more about the functioning of the markets, they consider the investment problem as being less complex, thus reducing their risk aversion towards investing. Hibbert, Lawrence, and Prakash (2013) study the gender gap in financial risk aversion and reach the conclusion that while men usually invest more in risky assets, men and women with equally high levels of financial education are equally likely to invest a significant portion of their wealth in risky assets, also suggesting that financial learning negatively impacts risk aversion. Shavit, Lahav, and Rosenboim (2016) similarly find that learning about the concepts of probabilities, asset risk and return, and portfolio management reduces perceived risk and thus increases the share of wealth invested in stocks. However, their conclusion is that it is not risk aversion in general, but just the financial risk aversion that is being influenced. Cox, Brounen, and Neuteboom (2014) analyse the link between financial literacy and risk aversion as well, but do not find any significant effect.

Wang (2009) proposes another link between financial literacy and risk aversion: objective financial knowledge and financial risk taking are highly correlated, but subjective knowledge mediates objective knowledge on risk taking, suggesting that the confidence level of the investor is an essential determinant of risk aversion. Related to this view, a body of the literature also discusses the potential role of overconfidence on investment behaviour, typically suggesting that overconfidence leads to excessive risk taking (Broihanne, Merli, and Roger, 2014; Odean, 1998) and decreases financial advice seeking (Kramer, 2014; Guiso and Jappelli, 2006). When evaluating the financial performance of individuals with a high degree of financial literacy, the literature does find mixed results (Hastings, Madrian, and Skimmyhorn, 2013; Cheng, Raina, and Xiong, 2014), which could suggest that overconfidence is present amongst this group of investors. In particular, Odean (1998) finds that overconfidence is prevalent when investors are less experienced.

Although not being entirely consistent on the effect of financial learning on risk aversion, however, the literature generally finds that financial literacy has a positive effect on stock market participation (Van Rooij et al., 2011; Guiso and Japelli, 2005; Grinblatt et al. 2011).

Other demographic characteristics

Controlling for various demographic characteristics of individuals often reveals differences in investment behaviour across groups. This may include, but is not limited to, gender, marital status, and religion. Findings on the impact of some demographic characteristics will be presented briefly in this section.

Findings often point towards that women are more risk-averse than men. This is both when it comes to whether or not they choose to participate in the stock market, the degree to which they do, and whether they are passive or active investors. Using data on over 35,000 households, Barber and Odean (2001) find that men trade more excessively than women due to a higher level of confidence. They also find that men's net returns are reduced by 2.65 percentage points due to trading, while for women the reduction is only 1.72 percentage points. Another study by Almenberg and Dreber (2015) also finds that women participate less in the stock market than men do. However, the gap becomes smaller after controlling for financial literacy. These findings are supported by e.g. Sundén and Surette (1998) and Dwyer et al. (2002).

The previously mentioned study by Sapienza et al. (2009) investigates how testosterone levels among men and women affect their degree of risk aversion. They find that among women, higher levels of testosterone were associated with lower levels of risk aversion, while this effect was found to be negative but insignificant among men. They conclude that there most likely exists a nonlinear relationship between testosterone and risk aversion such that at low levels of testosterone, a small increase in testosterone would have a negative effect on risk aversion. Additionally, they find that individuals with high levels of testosterone and lower levels of risk aversion were more likely to pursue risky careers in finance rather than management.

Bertocchi, Brunetti and Torricelli (2011) investigate the effects of gender and marital status on financial decisions. They find that, among women, singles are more risk-averse than those who are married. Additionally, they find that women with children also have a higher level of risk tolerance. Higher risk tolerance among married women is generally supported, e.g. by Sundén and Surette (1998), Spivey (2010) and Rybczynski (2015). For men, however, the effect appears to be opposite, with single men taking on more risk than married men (Yao and Hanna, 2004).

Empirical research (e.g. Leon and Pfeifer, 2013; Benjamin, 2016; Nielsen et al., 2017) finds that households who engage in religious activity often differ in terms of risk aversion. The level and sign is often dependent on the practiced religion, however.

In general, several demographic factors, as well as other factors, such as family history, geographic location, culture, macroeconomic outcomes, and various socioeconomic factors are likely to impact the investment behaviour of individuals, and covering or isolating all of them is usually difficult. Furthermore, many behavioural biases among individuals are present when investing. Some of the most well-known biases/puzzles and their consequences for empirical analyses will be covered next.

Behavioral Theories and Investment Behavior

Observable variables such as income, age and demographics only have limited explanatory power when it comes to identifying investment behaviour. Apart from these observables, there are many cognitive biases that affect whether and how individuals invest.

Developed by Kahneman and Tversky (1979), Prospect Theory criticizes utility theory and its rationality assumptions. Using a set of gambles, Kahneman and Tversky show that individuals are subject to various biases keeping them from taking entirely rational decisions. One such bias is the certainty effect, where people have strong preferences for certain outcomes over possibly more desirable, yet uncertain, outcomes. They demonstrate this in a manner similar to Allais' experiment.

Secondly, they demonstrate the isolation effect, showing that people may take different decisions when the same choice is demonstrated in different forms. Furthermore, they argue that people typically have a value function where the loss curve is steeper and convex, while the gains curve is less steep and concave. Finally, they argue that people have decision weights, weighing low probabilities more than high probabilities.

As an alternative approach to Prospect Theory, Loomes and Sugden (1982) propose a theory explaining behaviours similar to that explained by Prospect Theory, using regret as explanation for why individuals choose certain over uncertain outcomes. Loomes and Sugden argue that while picking something that is certain to avoid regret is in violation of the axioms proposed by von

Neumann and Morgenstern, doing so is not considered irrational, as the risk of feeling regret will weigh more negatively than picking a certain outcome.

Regret theory has later been used to explain other behavioural biases. Shefrin and Statman (1985) used it to explain the disposition effect, i.e. why people tend to sell winning stocks and keep losing stocks, while Engelbrecht-Wiggans (1989) used it to explain overbidding in auctions.

Another well-known behavioural bias is the Equity Premium Puzzle. Presented by Mehra and Prescott (1985), the puzzle questions why anyone would be willing to hold bonds rather than stocks, as stock have greatly outperformed bonds in the longer term. They find that under the assumptions of portfolio choice models, people would need to have a relative risk aversion coefficient above 30 to explain the historical return patterns.

Bernatzi and Thaler (1995) explain the puzzle using two behavioural concepts: loss aversion and mental accounting. Loss aversion is, as also explained by Prospect Theory, simply the idea that individuals are more averse to losses than they are drawn to gains; that is, there is a kink in the origin of the individual's utility function such that the loss function becomes steeper. Thus, individuals would choose less desirable expected outcomes to avoid losses. Bernatzi and Thaler found that, on average, people would be indifferent between winning \$61 against losing \$25 in a 50/50 gamble, where risk neutrality would imply a gain of \$25 to be indifferent, thus demonstrating a great degree of loss aversion. Secondly, they argue that people use mental accounts to code and evaluate financial outcomes. They argue that when people are loss averse, frequent evaluation of their portfolios will lead them to avoid riskier investments, as they feel the losses more than the gains. This is backed by a study by Samuelson (1963) who presents his colleague with a 50/50 gamble with a \$200 gain or a \$100 loss. When the colleague is presented with only one gamble, he rejects it due to loss aversion, yet when he is presented with 100 of those gambles, he accepts, as the total risk of losing diminishes.

Individuals' choices are also greatly impacted by the timing of the offer. Portfolio theory models usually assume that the risk preferences of individuals are constant across time. However, more often than not, risk preferences are not time-invariant. The majority of economics research related to time preferences has studied the quasi-hyperbolic function (Durlauf and Blume, 2008):

$$D(\tau) = \begin{cases} 1 & if\ \tau = 0 \\ \beta * \delta^{\tau} & if\ \tau = 1, 2, 3, \dots \end{cases}$$

where $D(\tau)$ is the discount factor as a function of time. The model implies that individuals are present-biased and have a relatively high short-run discount rate, while relatively low in the long term.

Apart from time-variant risk preferences, individuals may also change their risk preferences as a result of macroeconomic events/experiences. Malmendier and Nagel (2011) find that those who have experienced low stock market returns throughout their lives invest a lower fraction of their liquid assets in stock. The results are supported by Guiso, Sapienza and Zingales (2014) who find that risk aversion increased substantially among Italian bank clients after the financial crisis of 2008. This was the case even for clients who did not suffer any losses. In addition, Guiso et al. found, using a lab experiment, that watching a horror movie would lead people to become more risk-averse, thus using a fear-based explanation for the increase in risk aversion after the crisis.

Hypotheses

Based on the literature review, we set up the main hypotheses on which we base the study. First, literature presented mixed results on the effect of wealth on risk aversion. Since this may have important implications for our study, we must take into account the possible ways in which they might be related. Our first hypothesis thus simply states that wealth or income in some way affects financial risk aversion:

H1: Financial risk aversion is dependent on wealth/income

Next, our review of literature generally found that taking up additional years of education, especially at low levels of education, reduces the risk that individuals are willing to take. This leads us to the second hypothesis:

H2: Educational level has a positive effect on risk aversion

With respect to the effect of age on financial risk aversion, several factors were found to be relevant. Following behavioural research, risk aversion generally increases with age due to biological and developmental factors. In addition, the fact that human capital, defined as the number of remaining pay checks, decreases as the individual approaches retirement provides for a rational argument on why financial risk aversion should increases with age. However, empirical research on the topic generally finds that financial risk aversion, at least initially, decreases with age, which is attributed to individuals gaining more experience as investors and thus being less reluctant to engage in risky financial behaviour. Hence, we arrive at hypotheses 3a and 3b:

H3a: Age has a positive effect on financial risk aversion if driven by biological and developmental factors or decreasing human capital

H3b: Age has a negative effect on financial risk aversion if driven by stock market experience

The channel through which experience can be expected to influence financial risk aversion is through financial literacy; as investors gain more experience with the financial markets, the perceived complexity of the investment problem decreases and their confidence in being able to generate a good solution to the problem increases. This effect, in turn, results in perceived risk and eventually risk aversion being reduced. Based on this reasoning, we formulate the fourth hypothesis:

H4: Experience has a positive effect on financial literacy

Literature also finds that having a high level of numeracy or cognitive abilities can increase an individual's receptiveness towards financial learning significantly. We label these abilities as analytical abilities:

H5: Analytical abilities have a positive effect on financial literacy

Consistent with the findings of literature, we expect that individuals with an education in economics or finance have higher financial literacy than average since they have been taught about essential concepts such as probabilities, asset risk and return, and portfolio management throughout their education:

H6: Education in economics or finance has a positive effect on financial literacy

As already outlined, we link stock market experience, analytical abilities, and economics education to risk aversion by suggesting that they each have an intermediate positive effect on financial literacy, which in turn reduces risk aversion with respect to investments:

H7: Financial literacy has a negative effect on financial risk aversion

Research from behavioural economics, however, suggests that financial literacy may lead to overconfidence. This particularly seems to be the case if the individual has limited experience with the stock market:

H8: Without experience, financial literacy may lead to overconfidence

Finally, we consider the empirical results suggesting that individuals with high levels of analytical abilities in general have inherently lower risk aversion due to their ability to solve complex problems more efficiently. We thus propose the following hypothesis:

H9: Analytical abilities have a negative effect on risk aversion

Methodology

Methodological Considerations & Measurement

Utility-based vs. behavioural theory

In the literature review, we were presented with two competing theories on economic behaviour. One view is the utility-based view on which the theoretical frameworks and corresponding measures of risk aversion were built. This view assumes that individuals base their decisions on a set of rational decision rules and always choose the option that maximizes their expected utility. The behavioural view, on the other hand, argues that individuals do not actually maximize their utility, as they are subject to behavioural biases and cognitive restrictions. Although this view does acknowledge that individuals may attempt to maximize expected utility, it emphasizes that a number of subconscious factors will, however, inevitably interfere with the decision-making process, making the decisions made by individuals suboptimal. Thus, this view is somewhat sceptical to modelling human behaviour by simply assuming some global utility function.

The argument of the behavioural view naturally leads to asking the question of whether the utility-based approach to measuring risk aversion is valid at all. Although dispute prevails in academia as to the relative importance of each view, most economists do acknowledge the contributions of both views. In particular, the two views are not necessarily always contradictory, but may be considered complementary. As covered in the literature review, behavioural theory may sometimes argue that a bias, such as regret aversion, is, in fact, rational, since individuals' utility could also be a function of fear, and utility-based theory may take into consideration behavioural results, such as time-varying risk aversion, by modelling it into the utility function.

It is common for the utility-based approach to make use of objective measures, such as measuring the ratio between risky assets held and total assets or total wealth owned (Riley and Chow, 1992). Using this approach, one may draw inferences in line with the mean-variance framework (Markowitz, 1952), assuming that individuals who invest a lot in risky assets relative to their worth take up a higher degree of risk in order to realize a higher expected return. It is further possible to back out the Arrow-Pratt measure of risk aversion by assuming a portfolio choice model and a type of utility. This method is applied by e.g. Friend and Blume (1975) and Morin and Suarez (1983), who based on the ratio between risky assets and total assets derive the relative risk aversion coefficient, assuming CRRA. Alternatively, utility-based research can make use of gambling questions, presenting people with a number of different gambles and using their answers to estimate their risk aversion given some utility function (e.g. Barsky et al., 1997).

One weakness of the behavioural view is the lack of superior alternatives for measuring variables such as risk aversion. One may use subjective measures to estimate risk aversion, such as self-reported risk tolerance (Grable, 2000; Chaulk et al, 2003). In fact, including a subjective measure of risk tolerance in questionnaires has become a common approach for public surveys, e.g. The Survey of Consumer Finances (SCF). However, although this alternative avoids making use of any utility-based elements, it suffers from being dependent on framing, subjective evaluations, and potential cognitive biases. To some extent, it can be argued that the role of the utility-based approach is to measure how people actually act in terms of risk tolerance, while the behavioural approach seeks to explain why individuals may fail to act in an optimal way by identifying relevant biases (e.g. Shefrin and Statman, 1985; Bernatzi and Thaler, 1995).

Observational vs. experimental approach

Another issue that requires some attention is that of data collection. The majority of studies reviewed on the topic of financial risk aversion base their analyses on observational data from extensive surveys such as The Survey of Income and Program Participation or the Survey of Consumer Finances (e.g. Morin and Suarez, 1983; Riley and Chow, 1992). One benefit of using observational data on investment behaviour is that this shows how people actually invest and allocate their wealth between risky and safe assets, thus reflecting the actual financial risk they take up. However, according to the behavioural view, measuring risk aversion based on observational data can be problematic since individuals are arguably subject to a number of biases and may thus allocate their wealth based on other factors than just their degree of risk aversion. Observational data further fails to consider the financial risk aversion of those who are not participating in the stock market; some econometric methods may partly eliminate this issue, however. The use of experimental data based on gambling questions, on the other hand, could also potentially eliminate this issue.

Experimental data has the advantage that it is possible to tailor the experiment as needed to answer the research question; this is of course beneficial, especially in cases where the research question might be complex to answer using observational data. Further, experiments are controlled, which suggests that, if the experiment is carefully designed, it may be possible to avoid some of the behavioural biases that are usually present.

However, constructing experiments is usually quite resource consuming. Further, experiments are often conducted mainly on students since most other people are less willing to participate in experiments given the modest size of the participation rewards. This is likely to produce biased results if inference is to be made on the whole population (Sears, 1986). Further, the behaviour of people in experiments may not reflect the true risk that people are willing to take either – some people might be more willing to take risk in a constructed scenario since stakes are generally small and the gambling money is given to them.

What is one method's benefit is often the other methods' shortcoming. The benefit of using observational data rather than experimental data is namely that the studies are usually conducted by large organizations (or even states), mostly covering a representative sample of the population. On the contrary, the data is rarely gathered for one specific purpose, and one may have to rely on proxies and other approximations to answer their own specific research question. Despite this shortcoming, observational data is widely used for analysis, as it is often comprehensive enough to estimate a reasonable model.

Data

For this study, we will make use of observational data. The main reason for not conducting a tailored experiment is the lack of sufficient resources for constructing a good experiment. Further, experiments on the topic have already been conducted (Zhou, 2013), and we wish to contribute to existing literature by confirming and analysing them for the whole population. Data from the Survey of Income and Program Participation (SIPP) gathered by United States Census Bureau will be used. The survey is a household-based survey designed as a continuous series of national panels (Census, 2017). The survey collects comprehensive data on households' and individuals' income, asset ownership, expenditures, education, occupation, family dynamics, and many more variables used to measure of financial well-being. Each panel consists of several waves with various topics. The core dataset consists of 105,664 individuals spread across 42,030 households, where the total number of observations of each topical module may be lower and deviate slightly across modules.

For this study, the 10th wave of interviews from the latest Panel 2008 data set will be used. For this wave, individuals were interviewed in the period from September 2011 to December 2011. This topical module covers, apart from the core questions, topics on households' asset allocation and real estate. This wave was picked to make use of the most recent data and pick a time period not overlapping too much with the financial crisis of 2008, as this could have an effect on asset and real estate data. While the crisis may still have affected individuals' behaviour by 2011, the effect is expected to be relatively limited compared to e.g. 2008 or 2009. The wave consists of 79,321 individuals spread across 29,751 households. However, not all of these fit the requirements for this study.

Regarding data on educational background, the data set does unfortunately not contain very detailed information. It does, however contain information on people's occupation as well as their highest finished degree. We choose to include only individuals who have finished a two-year associate's degree or higher in order to analyse the difference between economists and non-economists, controlling for the level of education.

Further, the household must hold some equity in stock in order for us to measure their risk aversion. We thus exclude individuals without stock from the data set.[1] Finally, we focus on individuals

[1] Note that SIPP measures equity in stock as value of stock less any debt held against it (U.S. Census, 2017). Thus, only households with positive stock holdings are considered in this study, to avoid negative ratios between stocks and total assets.

within the working age since investment behaviour of retired people is often found to be quite different (as found by e.g. Morin and Suarez, 1983). We thus exclude households the reference person is not in the working age; we require a minimum age of 22 to ensure that the household is likely to have an income source, and a maximum age of 65 years is set to cut out households where the reference person is retired. These restrictions results in a data set of 2,621 households to be used for the investigation of the proposed hypotheses.

Variables

For measuring risk aversion, we follow the approach of Riley and Chow (1992) and construct a simple measure of risk aversion that evaluates the share of assets invested in risky assets. This measure is chosen mainly due to its simplicity. Further, the interest of this analysis is not to compare the risk aversion coefficients found with those of other studies, but rather to determine a relationship between risk aversion and having an economics-related education. It is thus not necessary back out an Arrow-Pratt risk aversion measure.

More specifically, we define our dependent variable, α, by the ratio of risky assets held to total liquid financial assets owned. Risky assets include investments in stocks and mutual funds, while total liquid financial assets is the sum of risky assets, savings and investments in banks or other financial institutions, and other liquid assets. It should be noted that this variable strictly speaking is a measure of risk tolerance rather than risk aversion. However, one can easily transform α into a measure of risk aversion by calculating $1 - \alpha$.

While some studies use net worth or total wealth as scaling rather than total liquid financial assets, we argue that this could be misleading, as highly illiquid assets, such as housing and cars as well as debt may create a skewed measure of the risk taken since they cannot be altered in the short run. Instead, we control for housing variables in the regressions; here, we apply dummy variables to indicate whether the household owns the house they live in, as well as a dummy indicating whether they have any other investments in real estate.

Due to the limited data on education, we use occupation as a proxy for education. The data set includes detailed information on the occupation titles of the subjects. Since only individuals with an associate's degree or higher are included, we expect their degree to be related to their occupation.

The occupation codes used to proxy economists are listed in Appendix 1. In particular, we have included occupations for which significant coursework in economics or finance is expected to be required.

The following list includes the most essential variables for our analysis:

α_i = Ratio between risky and total liquid assets for household i, measuring risk tolerance;
Age_i = Age of the reference person of household i;
$Income_i$ = Monthly household income for the reference month for household i;
$ownHouse_i$ = Dummy representing whether the household has equity in own housing;
$extraHouse_i$ = Dummy representing whether the household has equity in extra housing.
$Economist_i$ = Whether the reference person of household i is an economist.
$Master_i$ = Dummy representing whether the reference person of household i holds a master's degree.

Due to the fact that SIPP seeks to survey households participating in government programs, they have a larger representation of low income families. To make the data more representative of the actual population, sampling weights have been provided for each individual or household, indicating the number of individuals or households with similar characteristics in the total population. These weighting variables will be applied in the regressions in order to remove the potential sampling bias.

Models

This section describes all the models that will be estimated in order to investigate the research question thoroughly.

Initially, a model is proposed to test the effect of relevant economic control variables on investment behaviour. Following our hypotheses, we are, in particular, interested in the effects of income, age, and educational level on risk tolerance. We model a WLS regression[2], regressing the risk tolerance measure on the variables of interest, as well as the control variables related to real estate:

$$\alpha_i = \beta_0 + \beta_1 Income_i + \beta_2 ownHouse_i + \beta_3 extraHouse_i + \beta_4 Master_i + \gamma_1 Age_i + \gamma_2 Age_i^2 + \epsilon_i \tag{1}$$

[2] For the WLS regression, the sample weights provided by SIPP will be used.

Age^2 is included in the regression in order to check for a nonlinear relationship between age and risk tolerance.

The purpose of the following models is to investigate the impact of economic education on risk tolerance. Several different models are proposed to check for robustness in results.

$$\begin{gathered}\alpha_i = \beta_0 + \beta_1 Economist_i + \beta_2 ownHouse_i + \beta_3 extraHouse_i + \beta_4 Master_i + \gamma_1 Age_i + \gamma_2 Age_i^2 \\ +\delta_1(Economist_i * Age_i) + \delta_2(Economist_i * Age^2) + \theta_1(Master_i * Economist_i) + \epsilon_i\end{gathered} \tag{2}$$

Model (2) is the most basic model, adding a dummy for whether the household's reference person is considered an economist according to the criteria specified. In addition, interaction terms are added in order to test for differences between economists and non-economists with respect to the age effect and the educational effect.

Although the approach of including Age^2 in the regression in order to detect a possible nonlinear age effect is beneficial for determining a general trend, another approach is proposed to detect a potentially more complex relationship between α and Age. We construct dummy variables for age intervals of five years, resulting in the intervals 22-25, 26-30, 31-35, 36-40, 41-45, 46-50, 51-55, 56-60, and 61-65. We choose the age interval 26-30 as the reference group, and denote the remaining 8 age intervals by $j \in \{1, 2, \ldots, 8\}$. We thus estimate the following model:

$$\alpha_i = \beta_0 + \beta_1 Economist_i + \beta_2 ownHouse_i + \beta_3 extraHouse_i + \sum_{j=1}^{8} \gamma_j Age_{ij} + \sum_{j=1}^{8} \delta_j \left(Age_{ij} * Economist_i\right) + \epsilon_i \tag{3}$$

where Age_{ij} is the dummy for age group j for household i.

It is not necessarily just the reference person in the household whose educational background matters when it comes to risk tolerance. We conjecture that simply the fact that the household holds a person with the relevant educational background might have an effect. Thus, a model is proposed to include all households where an economist is present to account for this as well as to serve as a robustness check for model (2). We thus introduce a new dummy variable, $hasEconomist_i$ which indicates whether an economist is present in household i. This leads up to the following model:

$$\begin{gathered}\alpha_i = \beta_0 + \beta_1 hasEconomist_i + \beta_2 ownHouse_i + \beta_3 extraHouse_i + \beta_4 Master_i + \gamma_1 Age_i + \gamma_2 Age_i^2 \\ +\delta_1(hasEconomist_i * Age_i) + \delta_2(hasEconomist_i * Age^2) + \theta_1(Master_i * hasEconomist_i) + \epsilon_i\end{gathered} \tag{4}$$

Similar to model (2), model (3) will also be tested with $hasEconomist$ rather than $Economist$ in order to check if any differing patterns can be found for the households in which an economist is simply present. Hence, the model:

$$\alpha_i = \beta_0 + \beta_1 hasEconomist_i + \beta_2 ownHouse_i + \beta_3 extraHouse_i + \sum_{j=1}^{8} \gamma_j Age_{ij} + \sum_{j=1}^{8} \delta_j \left(Age_{ij} * hasEconomist_i\right) + \epsilon_i \tag{5}$$

As indicated by the hypotheses on which we build the study, it may be expected that individuals with high analytical abilities, similarly to individuals with an economics background, are more risk tolerant than the average individual. This poses a problem for our study design, as they may push the average risk tolerance of non-economists upwards, potentially making it difficult to spot any difference between economists and non-economists even if there actually turns out to be a difference. In order to deal with this issue, we propose the idea that individuals with a highly quantitative background in general may have higher than average analytical abilities as they as a minimum are expected to be more skilled with respect to numeracy. Thus, we next approach the problem by controlling for having other quantitative backgrounds than economics. In this category, we mainly include engineering and quantitative natural sciences such as mathematics and physics. The full list of occupational codes included in this category can be found in Appendix 1.

Applying this approach further allows us to analyse the channel through which the risk aversion of economists is influenced. If economists and quants turn out to be similar in risk aversion, while investors in neither category are more risk-averse, we would expect analytical abilities to be the main driver of the risk aversion of economists. If, on the other hand, economists are less risk-averse than quants, overconfidence amongst economists is a likely driver.

We construct the variable $Quant$, which is a dummy variable denoting whether the reference person of the household has a quantitative background other than economics (from now on referred to as 'quants'). Building on model (4), we estimate the following model:

$$\alpha_i = \beta_0 + \beta_1 Economist_i + \beta_2 Quant_i + \beta_3 ownHouse_i + \beta_4 extraHouse_i + \sum_{j=1}^{8} \gamma_j Age_{ij} + \sum_{j=1}^{8} \delta_j \left(Age_{ij} * Economist_i\right) + \sum_{j=1}^{8} \theta_j \left(Age_{ij} * Quant_i\right) + \epsilon_i \tag{6}$$

Descriptive statistics

Table 1 presents some descriptive statistics for our sample. Summary statistics are provided for five variables: investments in stocks, total liquid financial assets, the ratio of stocks to total liquid assets, income, and age. The summary statistics are presented for the full sample as well as for households with economists.

Glancing at the stock, assets and income for the entire sample, one will notice a relatively high average, compared to the 25%-, 50%- and 75% quartiles. This indicates a greatly right skewed distribution of these variables, which is also verified by the corresponding histogram in Appendix 2. This is no surprise, as one should expect more people with low income and wealth than people with a high or very high income and wealth.

However, looking at the ratio between stocks and assets, the average is much closer to the median. Thus, the distribution seems much less skewed for the ratio variable, as also verified by the corresponding histogram for the ratio in Appendix 2. Naturally, the age variable seems to follow a less skewed distribution as well. Although, as noticed from the age histogram in Appendix 2, the age distribution in the sample is skewed to the left due to the exclusion of the older segment from age 66 and up.

Looking into households where the reference person is an economist and those where an economist is present, they actually appear to have slightly lower stock investments as well as assets; the ratio between the two is also slightly lower. Looking at the histograms of economist households in Appendix 2, they show more households with a mid-level of stocks and assets, yet fewer with large investments in the two. Despite their lower investments in assets, the average income for economists is higher than the average for the entire sample, having relatively more households with a relatively high income.

One should notice that there are relatively fewer older people among the economists compared to the entire sample. Thus, it is likely that, despite their higher income, many of the economists have not yet built up the same level of assets due to their younger age.

Table 1 - Summary statistics for stock market participants: Full sample, Economist and hasEconomist[3]

Variable	N	Mean	Mean*	Std.dev	Std.dev*	1st Quartile	2nd Quartile	3rd Quartile
				Full sample				
Stock	2621	98,603.94	98,969.2	167,279.67	168,766.67	7,000	30,000	105,850
Assets	2621	157,320.28	157,606.84	237,386.16	240,778.26	22,000	67,500	187,700
Ratio	2621	0.58	0.58	0.33	0.33	0.29	0.63	0.89
Income	2621	10,601.34	10,486.81	8,434.95	8,450.86	5,302	8,668	12,975
Age	2621	48.06	47.53	11.01	11.1	40	49	57
				Economist				
Stock	208	90,921.5	86,344.74	149,955.8	144,182.98	7,000	30,000	85,750
Assets	208	155,802.41	150,070.96	225,889.98	222,811.38	20,750	61,025	174,456.5
Ratio	208	0.55	0.54	0.33	0.33	0.28	0.56	0.86
Income	208	11,618.96	11,568.19	9,289.69	9,471.4	5,332.5	9,739	14,041.75
Age	208	46.13	45.32	10.93	11.16	38	47	55
				hasEconomist				
Stock	317	92,613.2	88,877.54	149,752.91	146,457.17	8,000	30,000	100,000
Assets	317	154,640.78	150,963.62	216,503.37	214,965.35	22,300	64,000	197,165
Ratio	317	0.57	0.56	0.32	0.33	0.3	0.62	0.87
Income	317	12,399.32	12,285.4	9,189.92	9,309.46	6,501	10,335	14,729
Age	317	46.3	45.84	11.16	11.15	38	47	56

Expected results

Before estimating the proposed models, we will illustrate what we might expect from the estimated models, based on the hypotheses constructed.

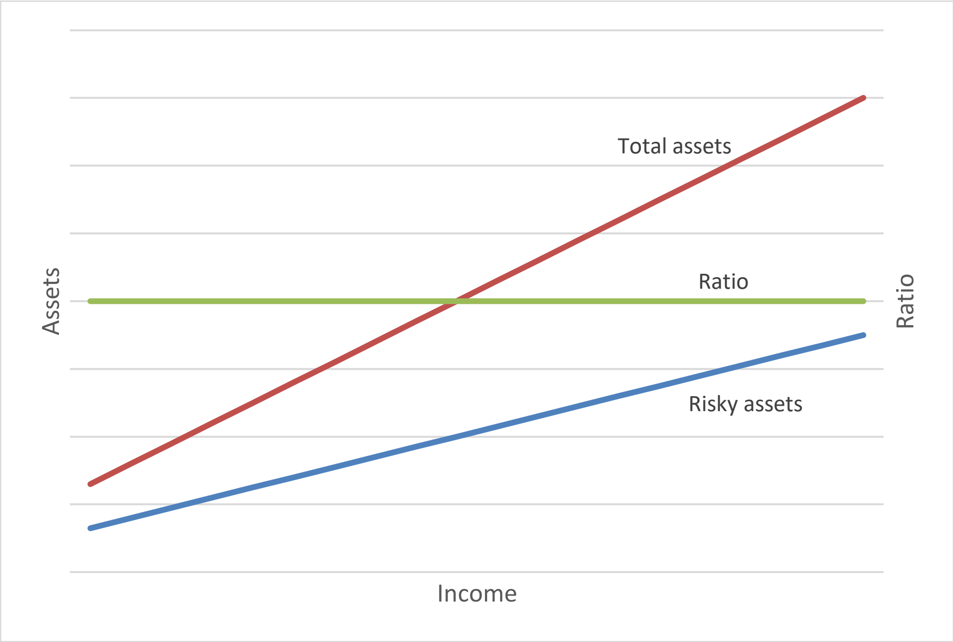
Income effect

Initially, we expect that as current income increases, so will the level of wealth. Furthermore, if individuals exhibit CRRA utility, then as total wealth increases, the investor will invest more into risky assets. This is illustrated by figure 1, showing that as income increases, we expect the investor

[3] Note that Mean* and Std.dev* refer to the probability weighted means and standard deviations, respectively

to put more aside, and thus the absolute amount of wealth and investment in risky assets will increase, while the ratio between the two remains constant.

Figure 1 – Risky and total assets with income, CRRA



Should the investor, on the other hand, display either DRRA or IRRA, their development would look slightly different. In the case of DRRA, the investment in risky assets would increase relatively more with increases in wealth, and the contrary would be the case for IRRA, as illustrated by figures 2 and 3.

Figure 2 - Risky and total assets with income, DRRA

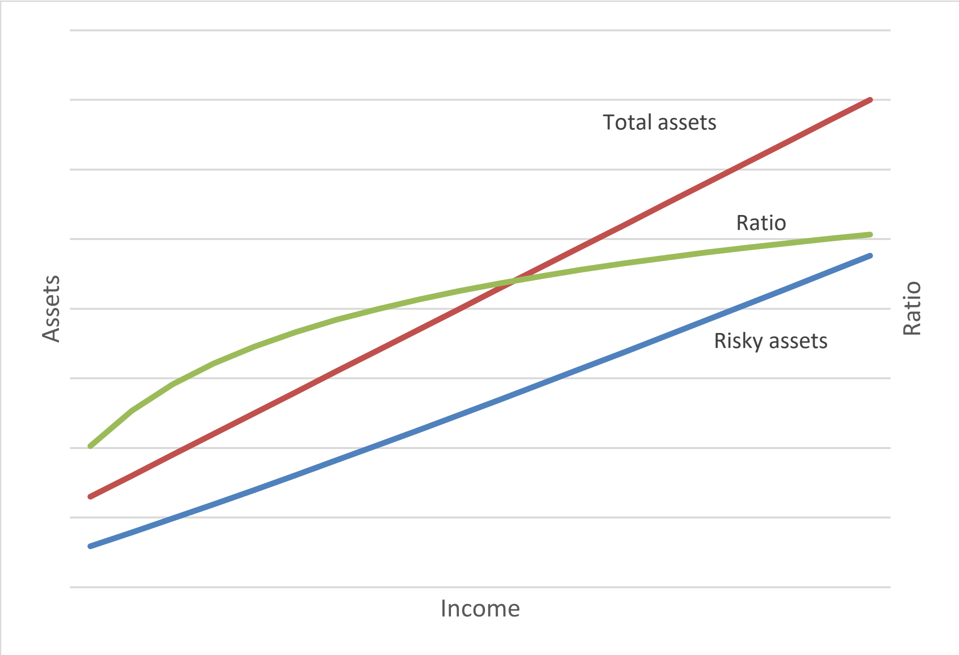
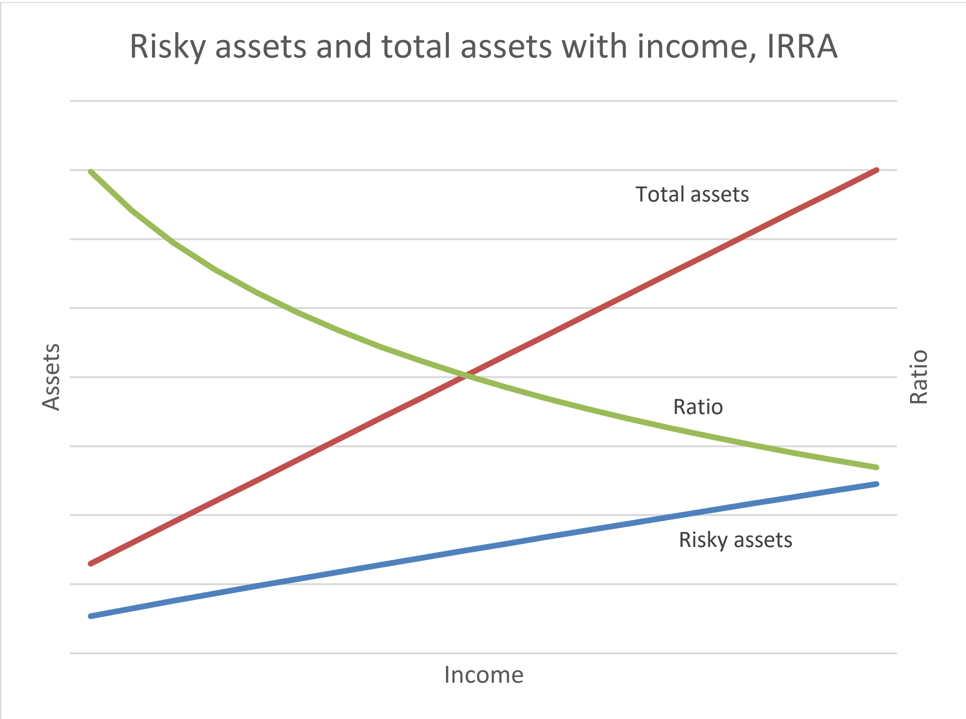


Figure 3 - Risky and total assets with income, IRRA



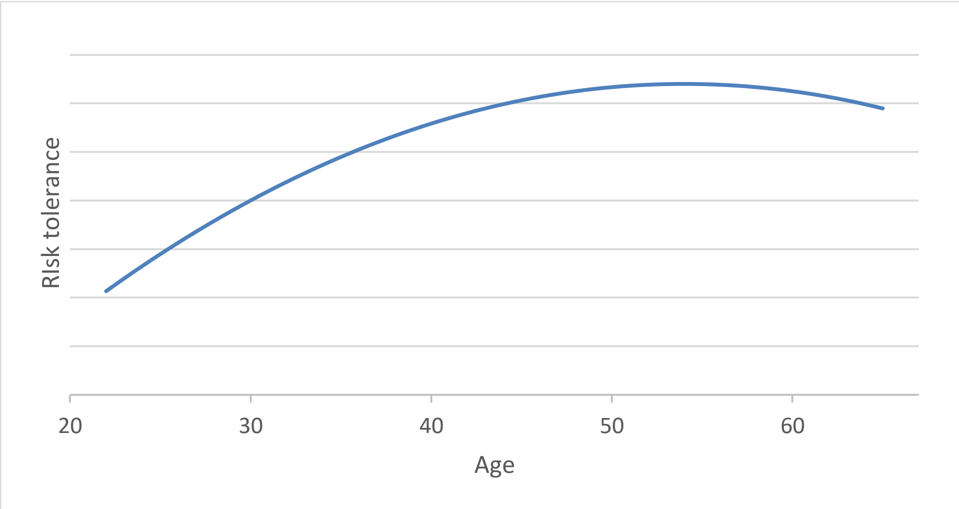
Age effects

Based on our hypotheses, we might expect various scenarios for the development of risk tolerance with age. Here, we characterize how this relationship is expected to develop depending on the drivers of the age effect.

Experience

In the first scenario, as seen from Figure 4, we illustrate an investor, whose development with age is purely characterized by stock market experience with age as well as by the expected increase in risk aversion as they approach their retirement age, resulting from decreasing human capital (DHC). This effect is thus represented as a concavely increasing function, where the investor puts a higher proportion of their wealth into risky assets as their experience with risky assets increases, thus allowing them to take more risk. As they get closer to retirement, they will, however, lower their proportion of wealth invested in risky assets, as hypothesized by Bakshi and Chen (1994). This model is expected to describe the behaviour of the average investor who was not influenced by the potential effects of economics learning or exceptionally high analytical abilities.

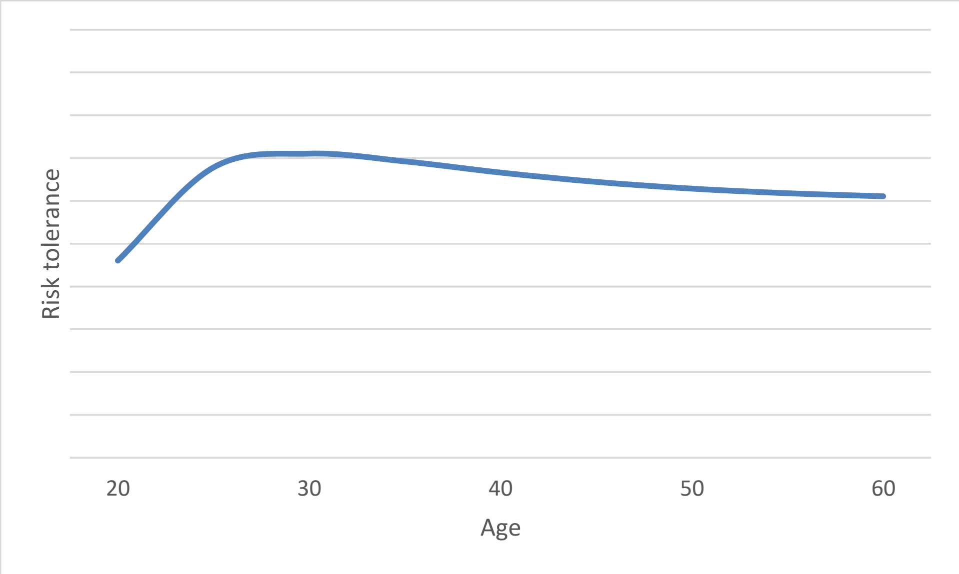
Figure 4 – Risk tolerance with age, experience + DHC



Financial Literacy

In the second scenario, we assume an investor who initially possesses high levels of financial literacy, possibly acquired through their education. This investor will take on more risk already at an early stage, as they can manage the complexity of the stock market. In this scenario, we assume that the effect of aging (lower human capital) will be stronger than that of experience, as the experience level of the investor is already high initially. Thus, the investor’s risk tolerance will decrease slightly as they age they face DHC.[4] This scenario is illustrated in Figure 5. We may expect economists and quants to fall into this category.

Figure 5 - Risk tolerance with age, financial literacy + experience + DHC

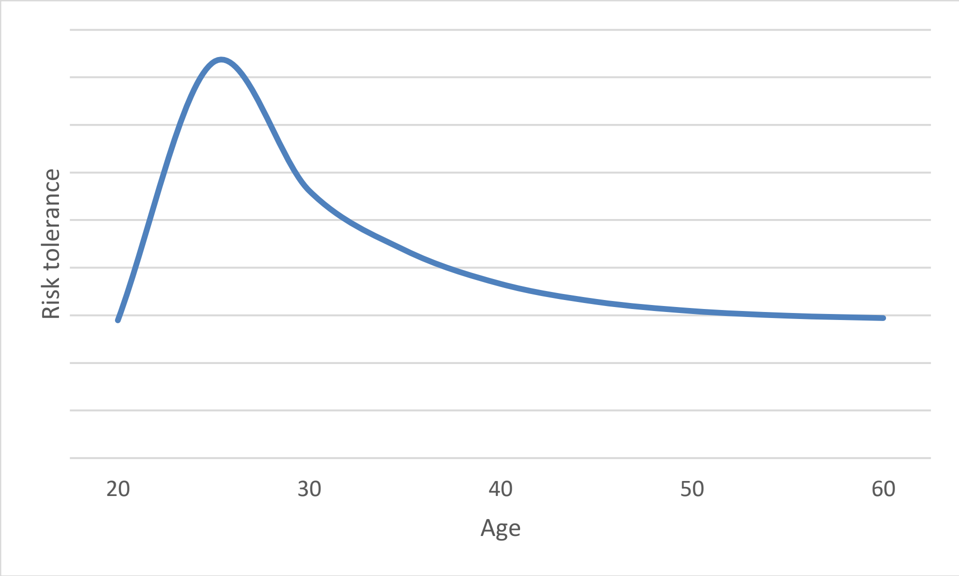


Overconfidence

We expect overconfident investors to display an initially steeply increasing level of risk tolerance as they become acquainted with the stock market, since they believe that this acquaintance with the market makes them superior investors, thus investing a large proportion in risky assets. As they realize with experience that their investments are in fact not better, or perhaps they even realize losses, they lower their proportion invested in risky assets quite fast, after which their risk tolerance slowly drops as they approach retirement. Figure 6 shows this pattern. Since economists and quants, in particular, may be subject to overconfidence due to their initially high levels of financial literacy, this scenario might also describe their investment behaviour with age.

[4] Note that this development does not assume that investors will not start investing until they have e.g. purchased their house.

Figure 6 - Risk tolerance with age, overconfidence + experience + DHC



Economics education

According to hypotheses 6 and 7, we would expect economists to have a lower perceived risk due to financial literacy and analytical abilities, thus having a higher level of risk tolerance. Ceteris paribus, this group of investors should acquire a relatively higher risk tolerance at an early age, decreasing slightly towards retirement, as their human capital decreases. Although average investors for the most part are expected to increase their risk tolerance with age, we expect that their level of risk tolerance around the ages of 50-65 is comparable to that of economists within the same age group. This is because the main drivers of risk aversion at this point are expected to be experience and decreasing human capital for all investors.

We may also expect some differences between economists and quants since they differ slightly with respect to their drivers of risk tolerance. Economists generally acquire some financial literacy before their analytics abilities and experience with the stock market develop; thus, we would expect them to be subject to overconfidence to a higher degree than quants. On the other hand, we would expect the analytical ability of quants to have developed further before they become acquainted with the stock market and decide to invest in risky assets. Thus, we would expect their risk tolerance to develop more in line with Figure 5 as they are expected to be less influenced by overconfidence by the point they start investing in risky assets.

Results

This section will present the results of each model discussed in the methodology section. This part will be split into four subsections, according to: 1) Investigation of the impact of age, income, educational level, and housing on risk tolerance. 2) Risk tolerance analysis of households with a reference person holding an economics education. 3) Risk tolerance of households with any person holding an economics education. 4) Risk tolerance of economist households when controlling for quant households.

Impact of Age, Income, Educational Level, and Housing

The results from the WLS regression of model (1) are listed in Table 2.

Table 2 - Model (1) regression results

	Coef.	Std. Err.	t	P>|t|
Age	.0161649	.0056903	2.84	0.005***
Age2	-.0001544	.0000605	-2.55	0.011**
Income	-1.97e-08	7.96e-07	-0.02	0.980
ownHouse	.0196541	.0213302	0.92	0.357
extraHouse	-.0265275	.0165422	-1.60	0.109
Master	-.0066095	.0144713	-0.46	0.648
_cons	.1712495	.1263097	1.36	0.175
F(6, 2614) = 3.19				
Prob > F = 0.0040				
R-squared = 0.0099				
Root MSE = .32617				

* p < 0.10, ** p < 0.05, *** p < 0.01

We first note that age seems to have a significant effect on risk tolerance. Both Age and $Age2$ are significant, indicating a nonlinear relationship between the two variables. Since $Age2$ is negative, the curve has an inverse u-shape. That is, age has a positive effect first, after which the effect becomes negative. This is consistent with the expected results for the average investor, as outlined by Figure 4. In order to estimate the point at which the effect starts becoming negative, Age_{max}, we set the marginal effect of age equal to 0:

$$\frac{\partial \alpha}{\partial Age} = \beta_{Age} + 2\beta_{Age2}Age_{max} = 0$$

Isolating for Age_{max}, we get

$$Age_{max} = -\left(\frac{\beta_{Age}}{2\beta_{Age2}}\right)$$

By inserting the estimates for β_{Age} and β_{Age2} in the equation, we find that risk tolerance increases up until age 52, after which it decreases. This result is very consistent with the notion that investors increase their risk tolerance as they gain experience with age, but start decreasing it again when approaching retirement.

The $Income$ variable is highly insignificant and practically equals zero. Thus, the income level of the individual does not seem to influence the proportion of liquid assets that are allocated to risky assets, conditional on choosing to invest in such assets. Based on this result, we have no reason to suspect that investors exhibit anything other than CRRA utility. Due to its insignificance as an explanatory variable, income will removed from subsequent models.

The effect of educational level is further investigated by estimating whether investors holding a master's degree differ with respect to risk tolerance, relative to having only two or three years of post-secondary education. With a coefficient of -0.007 and a P-value of 0.65, educational level does not appear to be significant. This may be explained by a nonlinear educational effect which is stronger at lower levels of education but then reduces in significance as more education is obtained.

Finally, looking at housing, one can spot a positive, yet insignificant, impact from own housing, while owning housing that is not used for living has a negative and also insignificant coefficient. The negative sign on extra housing is expected; investors are likely to start diversifying if they have invested large amounts of wealth in stocks and thus switch some of their investments to housing rather than stocks.

Reference person is an Economist

Including the $Economist$ variable and the corresponding interaction terms in the regression model, the results from Model (2) are presented in Table 3. With a coefficient of about 0.24, the results suggest that economists do, in fact, invest a significantly larger share of their assets in stock, indicating that they are more risk tolerant. This is consistent with our hypotheses and the findings of

Zhou (2013). The coefficient is, however, not statistically significant, for which reason no strong conclusions can be made based on these results.

With respect to age, the marginal effect on risk tolerance for economists can be found by:

$$\frac{\partial(\alpha \mid Economist = 1)}{\partial Age} = \beta_{Age} + \beta_{EconomistAge} + 2(\beta_{Age2} + \beta_{EconomistAge2})Age$$

Hence, the hump of the age effect for economists can be estimated by:

$$(Age_{max} \mid Economist = 1) = \frac{\beta_{Age} + \beta_{EconomistAge}}{2(\beta_{Age2} + \beta_{EconomistAge2})}$$

By inserting the coefficient estimates, it is found that economists are the most risk tolerant at the age of 54. For non-economists, the hump is again found to be at age 52. This does not suggest much difference in the age effect between economists and non-economists. It should also be noted that the coefficients of the interaction terms are insignificant, which also indicates that there are no significant differences on the two groups.

Although $Master$ turned out to be insignificant in model (1), we still include it in this model in order to inspect if it interacts with the $Economist$ variable. With a coefficient of only about 0.003 and a P-value of 0.950 on $\beta_{MasterEconomist}$, the results suggest that the difference of the educational effect between economists and non-economists is insignificant both in economic and statistical terms.

Table 3 - Model (2) regression results

	Coef.	Std. Err.	t	P>|t|
Age	.01728	.0058639	2.95	0.003***
Age2	-.0001656	.0000621	-2.67	0.008***
Economist	.2384421	.4670803	0.51	0.610
EconomistAge	-.011313	.0212516	-0.53	0.595
EconomistAge2	.0001099	.000233	0.47	0.637
ownHouse	.0191848	.0213049	0.90	0.368
extraHouse	-.0258503	.0164477	-1.57	0.116
Master	-.0082219	.014812	-0.56	0.579
MasterEconomist	.0034841	.0553504	0.06	0.950
_cons	.1484431	.1314725	1.13	0.259
F(9, 2611) = 2.43				
Prob > F = 0.0095				
R-squared = 0.0110				
Root MSE = .32618				

* p < 0.10, ** p < 0.05, *** p < 0.01

In order to conduct a more detailed investigation of the age effect, we turn to model (3). Table 4 presents the results of this regression. The $Master$ variable has been removed in this regression due to its insignificance. The age dummies are constructed such that $AgeXX$ refers to the dummy for the age interval that starts at age XX. For example, $Age22$ refers to the age interval 22-25, while $Age31$ refers to age 31-35.

Similar to the results of model (2), it appears that the general age effect is significant, whereas the difference in age effect between economists and non-economists seems insignificant. Yet, we seek to analyse the trends in order to spot potential differences in the pattern.

For the non-economists, one can spot an initial decrease in risk tolerance with age until around age 31-35, after which risk tolerance increases significantly. Afterwards, the development seems less consistent, fluctuating moderately around the same level until retirement. Surprisingly, it appears that risk tolerance for this group is higher in the early 20s than in the early 30s, suggesting the presence of some overconfidence among non-economists. Figure 7 plots this age effect indicated by the age dummies for non-economists along with the general trend. On the y-axis of the graph, the difference in risk tolerance to that of the reference group is measured, where the reference group is age 26-30.

In Figure 8, we have presented a similar plot for economists. It has been constructed by calculating the difference between the risk tolerance for economists within each age group and that of the reference group:

$$\left(\alpha_{EconomistAge_j} - \beta_0\right) = \beta_{Economist} + \beta_{Age_j} + \beta_{EconomistAge_j}$$

The figure reveals a pattern in which risk tolerance initially is increasing until age 26-30 followed by a similar decrease. From the mid-30s, risk tolerance again increases and follows a pattern similar to that of non-economists. The initial behaviour is consistent with the hypothesis that economists are subject to overconfidence. However, comparing this trend to that of non-economists, it seems that economists are simply overconfident at a slightly later age, but are actually being more risk-averse initially. The magnitudes of the overconfidence of economists and non-economists are further comparable, both amounting to about 0.04 above the level of the reference group.

In Figure 9, the difference in risk tolerance between economists and non-economists across age groups is graphed. We see that the difference fluctuates around zero, with economists being more risk tolerant at age 26-30 and 41-45 and less risk tolerant in all other age groups. Taking the small magnitudes and the statistical insignificance of the differences into account along with the results obtained from model (1), however, it seems unreasonable to conclude that significant differences exist between the two groups. The general pattern for both groups still seems to exhibit an initial period of overconfidence, followed by an increase in risk tolerance in the mid-30s, possibly due to experience, and finally a slight decrease in risk tolerance when approaching retirement.

Table 4 - Model (3) regression results

	Coef.	Std. Err.	t	P>|t|
Age22	.0438503	.0704272	0.62	0.534
Age31	-.0086586	.0395934	-0.22	0.827
Age36	.1033995	.0381156	2.71	0.007***
Age41	.0633425	.0388306	1.63	0.103
Age46	.0995776	.0372413	2.67	0.008***
Age51	.0877736	.0364524	2.41	0.016**
Age56	.0650738	.0369775	1.76	0.079*
Age61	.0923613	.0370249	2.49	0.013**
Economist	.0400113	.0854884	0.47	0.640
EconomistAge22	-.133256	.2031867	-0.66	0.512
EconomistAge31	-.0617949	.1163798	-0.53	0.595
EconomistAge36	-.0953687	.1356988	-0.70	0.482
EconomistAge41	-.0248248	.1082364	-0.23	0.819
EconomistAge46	-.0845207	.1032503	-0.82	0.413
EconomistAge51	-.1020902	.1070386	-0.95	0.340
EconomistAge56	-.0941148	.1074278	-0.88	0.381
EconomistAge61	-.0757373	.1166889	-0.65	0.516
ownHouse	.0233404	.0213555	1.09	0.275
extraHouse	-.025143	.0164682	-1.53	0.127
_cons	.4985208	.032972	15.12	0.000***
F(19, 2601) = 1.73				
Prob > F = 0.0253				
R-squared = 0.0154				
Root MSE = .32607				

* p < 0.10, ** p < 0.05, *** p < 0.01

Figure 7 - Development in risk tolerance with age, full sample

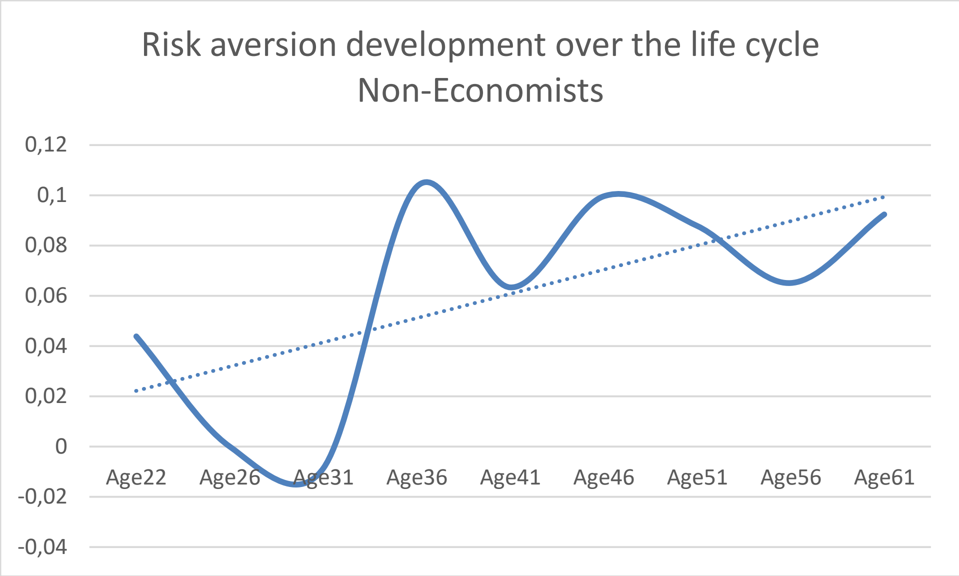


Figure 8 - Development in risk tolerance with age, economists

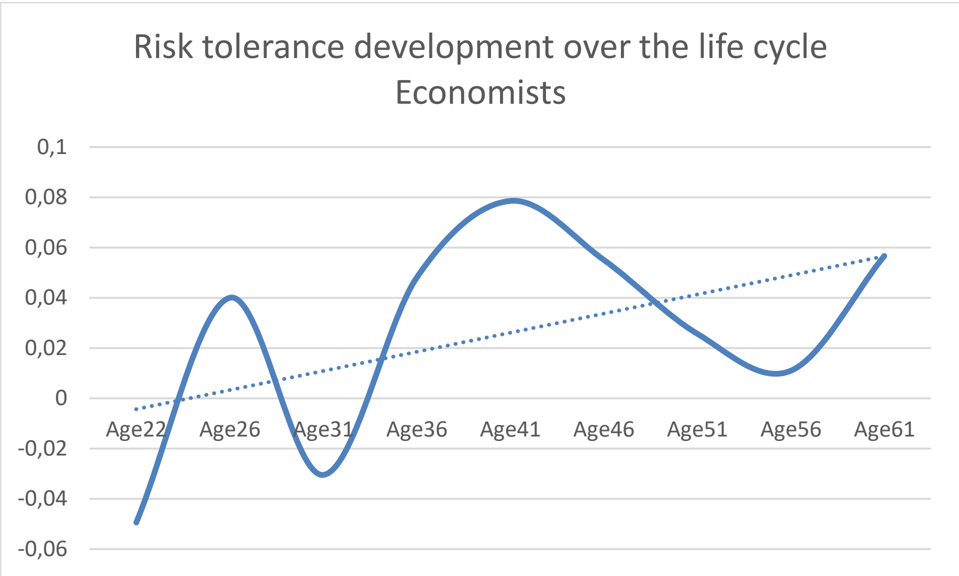
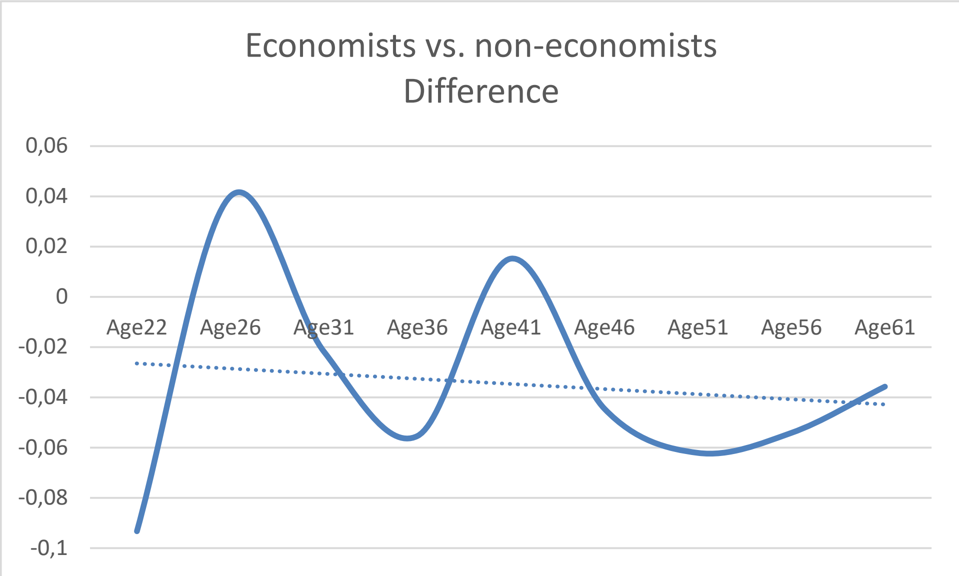


Figure 9 - Difference between economists' and non-economists' risk tolerance with age



Households where any person is an Economist

In model (4), model (2) has been modified to include $hasEconomist$ rather than $Economist$ in order to analyse whether the mere presence of an economist then may have an effect on risk tolerance. The results are presented in Table 5. The coefficient of $hasEconomist$ is estimated to be around 0.48, which is about twice as high as that of the $Economist$ variable in model (2). This suggests that households with economists allocate almost 50 percentage points more of their assets to risky assets, which is a notable difference. The coefficient, however, is again insignificant.

With respect to age, we generally see a similar concave effect for non-economists with a peak around age 52. Calculating the effect for households with economists in a similar manner to what was done for model (2), we find a convex age effect with trough around age 28. That is, risk tolerance is expected to decrease with age until age 28, after which it increases. Although this result is slightly different from previous results, it is consistent with the age patterns discussed previously; investors in general appear to exhibit a degree of overconfidence initially and decrease their risk tolerance with experience, followed by increasing risk tolerance in the mid-30s. Further, the coefficients on the interaction terms are not significant. It thus appears that no significant difference between households with and without economists can be found based on this model.

Table 6 further presents the results of model (5). Again, we see a similar pattern in the age dummies; in general, the age effect is significant, while the difference between households with and without economists is insignificant. One notable difference is that the interaction term between $hasEconomist$ and $Age41$is significantly negative at the 5% significance level. That is, households with economists where the reference person is between age 41 and 46 are less risk tolerant than those without economists. In light of our other results and the insignificance of the other interaction terms, we find it most likely that this, however, is simply a statistical anomaly that could lead to a type 1 error. We thus conclude that no significant difference in the general age pattern is to be found between the two groups.

Table 5 - Model (4) regression results

	Coef.	Std. Err.	t	P>|t|
Age	0.01882	0.00601	3.13	0.002***
Age2	-0.00018	0.00006	-2.9	0.004***
hasEconomist	0.48183	0.38452	1.25	0.21
hasEconomistAge	-0.0245	0.0174	-1.41	0.159
hasEconomistAge2	0.00028	0.00019	1.46	0.144
ownHouse	0.02049	0.0213	0.96	0.336
ExtraHouse	-0.02558	0.01644	-1.56	0.12
Master	-0.00768	0.0151	-0.51	0.611
MasterhasEconomist	0.00616	0.04596	0.13	0.893
_cons	0.11865	0.13518	0.88	0.38
F(9, 2611) = 2.49				
Prob > F = 0.0078				
R-squared = 0.0114				
Root MSE = .3261				

* p < 0.10, ** p < 0.05, *** p < 0.01

Table 6 - Model (5) regression results

	Coef.	Std. Err.	t	P>|t|
Age22	0.05748	0.07331	0.78	0.433
Age31	0.00703	0.04094	0.17	0.864
Age36	0.11018	0.03936	2.8	0.005***
Age41	0.09103	0.03969	2.29	0.022**
Age46	0.10708	0.03831	2.79	0.005***
Age51	0.09429	0.03769	2.5	0.012**
Age56	0.07537	0.03812	1.98	0.048**
Age61	0.09775	0.03818	2.56	0.011**
hasEconomist	0.08676	0.07421	1.17	0.242
hasEconomistAge22	-0.17478	0.16636	-1.05	0.294
hasEconomistAge31	-0.13619	0.09804	-1.39	0.165
hasEconomistAge36	-0.07172	0.10083	-0.71	0.477
hasEconomistAge41	-0.19046	0.09695	-1.96	0.050**
hasEconomistAge46	-0.09293	0.09011	-1.03	0.302
hasEconomistAge51	-0.09041	0.0878	-1.03	0.303
hasEconomistAge56	-0.12099	0.09159	-1.32	0.187
hasEconomistAge61	-0.05268	0.09506	-0.55	0.579
ownHouse	0.0226	0.02131	1.06	0.289
extraHouse	-0.02534	0.01646	-1.54	0.124
_cons	0.48878	0.03381	14.46	0.000***
F(19, 2601) = 1.88				
Prob > F = 0.0118				
R-squared = 0.0171				
Root MSE = .32579				

* p < 0.10, ** p < 0.05, *** p < 0.01

Including Quants

We wish to control for households that include individuals with other quantitative backgrounds in our analysis. In Table 7, the results from estimating model (6) are presented. We first note that including quants in the regressions does not seem to alter the significance of the $Economist$ variable or any of the corresponding interaction terms. We further note that neither the $Quant$ variable nor any of its interactions with Age are significant, which hints towards the conclusion that no significant difference is to be found between any of the three groups.

The signs of the interaction terms between $Quant$ and Age do, however, vary more compared to those between $Economist$ and Age, which are all negative. Since the reference levels of $Quant$ and $Economist$, as indicated by the estimates of β_{Quant} and $\beta_{Economist}$, are both higher than the reference level of the average investor, the varying signs of the interactions between $Quant$ and Age could suggest a consistently higher level of risk tolerance amongst quants. We check this conjecture by making a plot similar to that of Figures 7 and 8. Figure 10 graphs the risk tolerance of quants relative to the reference group.

From the figure, we do observe a slightly different pattern than what we have seen earlier. Although the pattern initially seems similar, with some degree of overconfidence first and then an increase in risk tolerance in the mid-30s, the quants seem to continuously increase their risk tolerance all the way up until retirement. Figure 11 plots the difference in risk tolerance across age groups between quants and average investors. We observe that quants in all age groups except for age 36-40 are more risk tolerant. In particular, the difference escalates as retirement is approached.

In summary, it appears that economists and average investors are similar, while quants differ at later stages of their life. As all the differences, however are statistically insignificant, it is difficult to confirm if any difference is actually present. We end this section by concluding that economists do not differ significantly from non-economists based on the estimated models.

Table 7 - Model (6) regression results

	Coef.	Std. Err.	t	P>|t|
Age22	.0429274	.0732353	0.59	0.558
Age31	-.0090304	.0437397	-0.21	0.836
Age36	.1182147	.0410267	2.88	0.004***
Age41	.0646861	.0417358	1.55	0.121
Age46	.1048816	.0401401	2.61	0.009***
Age51	.0937367	.038933	2.41	0.016**
Age56	.0648774	.0394164	1.65	0.100*
Age61	.0915349	.039244	2.33	0.020**
Economist	.0463073	.086561	0.53	0.593
EconomistAge22	-.1323729	.2044901	-0.65	0.517
EconomistAge31	-.060961	.1180562	-0.52	0.606
EconomistAge36	-.1096719	.1367128	-0.80	0.423
EconomistAge41	-.0257101	.1095007	-0.23	0.814
EconomistAge46	-.089218	.1044979	-0.85	0.393
EconomistAge51	-.1075613	.1081083	-0.99	0.320
EconomistAge56	-.0932828	.1084807	-0.86	0.390
EconomistAge61	-.0743534	.1175977	-0.63	0.527
Quant	.0366266	.0863259	0.42	0.671
QuantAge22	.0014177	.2136058	0.01	0.995
QuantAge31	-.0046081	.1037489	-0.04	0.965
QuantAge36	-.104777	.1063538	-0.99	0.325
QuantAge41	.0017758	.1080722	0.02	0.987
QuantAge46	-.0236946	.0997172	-0.24	0.812
QuantAge51	-.0265742	.1046343	-0.25	0.800
QuantAge56	.0641786	.1063363	0.60	0.546
QuantAge61	.146267	.1134999	1.29	0.198
ownHouse	.023059	.0214466	1.08	0.282
extraHouse	-.0268063	.0164312	-1.63	0.103
_cons	.4923569	.035597	13.83	0.000***
F(28, 2592) = 1.61				
Prob > F = 0.0228				
R-squared = 0.0188				
Root MSE = .32607				

* p < 0.10, ** p < 0.05, *** p < 0.01

Figure 10 - Development in risk tolerance with age, quants

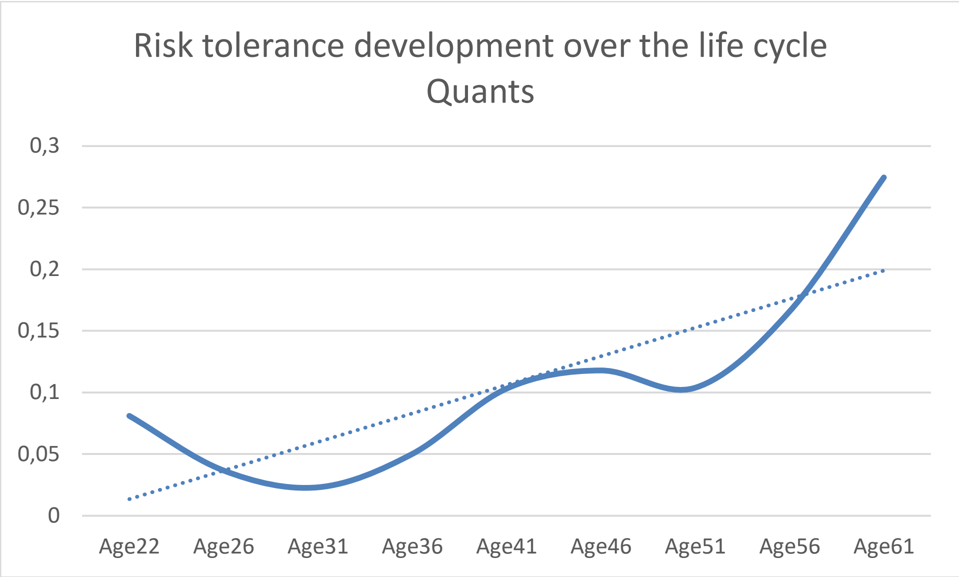
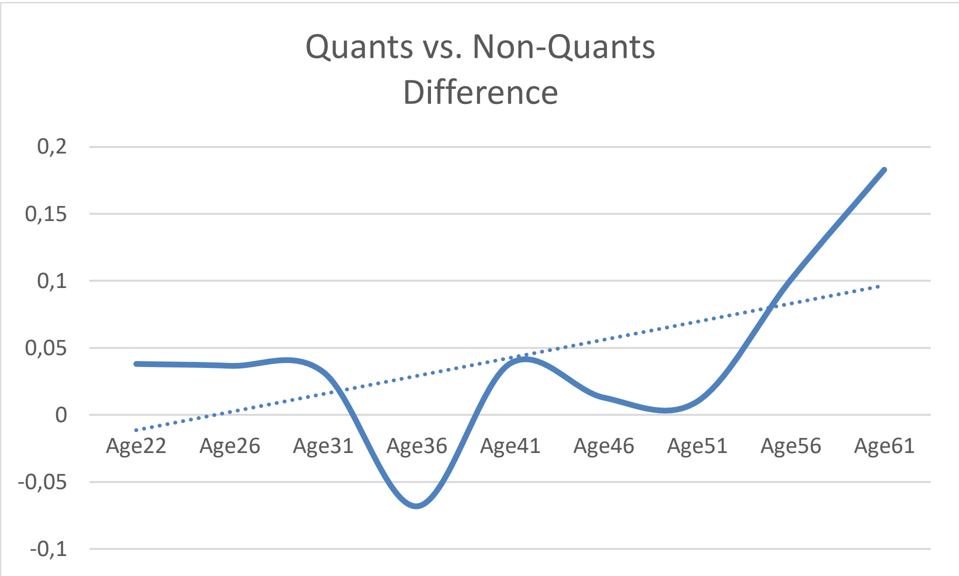


Figure 11 - Difference between quants' and non-quants' risk tolerance with age



Further Analysis

As the results so far indicate that there is no difference between economists and non-economists, we are curious as to whether this is also the case for stock market participation. Literature indicates a clear relationship between financial literacy and stock market participation. If economists are, in fact, more likely to participate in the stock market, economists may be overrepresented in our sample. This could potentially bias our estimates as the data set may suffer from non-random sampling with respect to the whole population.

In particular OLS/WLS estimation is only consistent and unbiased under the assumptions that 1) the model is linear in parameters, 2) the sample is random, 3) there is no perfect multicollinearity, and 4) the mean of the error term conditional on the explanatory variables is zero. In order to investigate whether assumption 2 is violated, we look into stock market participation for economists.

Participation

For investigating whether being an economist has an effect on stock market participation, we propose a binary response model, in which the dependent variable, y, indicates whether the household has stocks. In particular, $y = 1$ if the household does own stocks, while $y = 0$ if it does not. We expand the data set by relaxing the restriction that the households must have invested wealth in stocks and end up with 9,661 observations of which 593 are economist households. The following model is constructed to be estimated:

$$y_i = \beta_0 + \beta_1 Economist + \beta_2 ownHouse_i + \beta_3 extraHouse_i + \beta_4 Income_i + \sum_{j=1}^{8} \gamma_j Age_{ij} + \epsilon_i \tag{7}$$

We have included the $Income$ variable here again, as higher income is very likely to result in an increase in probability of stock market participation. The housing variables are further both expected to be positively correlated with stock market participation as they also relate to higher levels of wealth.

A probit estimation of the model is presented in Table 8. With a P-value of 0.000 and a positive coefficient estimate on $\beta_{Economist}$, the results Indicate that households where the reference person is an economist are significantly more likely to participate in the stock market. This is in line with the proportions of economists in each sample – In the restricted sample where all subjects were owners of stocks, the proportion of economist households was around 8%, while the same proportion was only about 6% in the unrestricted sample.

In addition, $Income$ and the housing variables also have a significantly positive effect on the likelihood of participation. With respect to age, it appears that participation is likely to increase as individuals approach retirement. Specifically, individuals of age 46 or higher are significantly more likely to participate in the stock market than individuals in the reference group.

Table 8 - Model (7) Probit regression results

	Coef.	Std.	z	P>|z|
Income	.0000375	2.76e-06	13.59	0.000***
Age22	.0393408	.1175258	0.33	0.738
Age31	.1028789	.0744753	1.38	0.167
Age36	.0192883	.0718946	0.27	0.788
Age41	.0612171	.0706624	0.87	0.386
Age46	.1962272	.0700064	2.80	0.005***
Age51	.2381126	.0697879	3.41	0.001***
Age56	.2586648	.0699798	3.70	0.000***
Age61	.3251017	.071022	4.58	0.000***
Economist	.2352571	.0600213	3.92	0.000***
ownHouse	.3872988	.0395025	9.80	0.000***
ExtraHouse	.3777228	.0437223	8.64	0.000***
_cons	-1.444605	.0608206	-23.75	0.000***
Log pseudolikelihood = -20746038				
Pseudo R2 = 0.0828				

* p < 0.10, ** p < 0.05, *** p < 0.01

Selection Bias

Since we find a positive effect of being an economist on the probability of participating in the stock market, we proceed with our treatment of the non-random sampling issue. At this point, it has been established that economists self-select into participating in the stock market, for which reason our previous results could potentially suffer from a selection bias. This bias is caused by the fact that we truncated our data set; the exclusion of households without any ownership of stocks causes the data to be truncated at 0. That is, we observed α if $\alpha > 0$, but not if $\alpha = 0$. In such a case, the selection bias can be corrected for by estimating the model with the Heckman two-step estimator.

We define

$$y = \begin{cases} 1 & if\ \alpha > 0 \\ 0 & if\ \alpha = 0 \end{cases}$$

The variable y is defined similarly to the previous section; y again reflects stock market participation. By including the interaction terms between $Economist$ and Age in model (7), a participation equation can be estimated by probit. Extracting the inverse Mills ratio, $\hat{\lambda}$, from this regression, we estimate the following outcome equation by OLS:

$$\begin{aligned} \alpha_i = \beta_0 + \beta_1 Economist_i + \beta_2 ownHouse_i + \beta_3 extraHouse_i + \sum_{j=1}^{8} \gamma_j Age_{ij} \\ + \sum_{j=1}^{8} \delta_j \left(Age_{ij} * Economist_i \right) + \theta \hat{\lambda}_i + w_i \end{aligned}, \quad \alpha > 0 \qquad (8)$$

The results of the estimation are given in Table 9. We notice that the age pattern still looks similar for investors in general. Although some age dummies are no longer significant, the coefficients still exhibit a pattern where risk tolerance initially drops and then increases during the mid-30s, after which it fluctuates slightly around the same level until retirement.

The $Economist$ variable along with its interactions with the age dummies are all still insignificant. The magnitudes further seem to be comparable to those estimated by model (4). Thus, even when accounting for the potential selection bias in the original models, it is found that 1) economists do not exhibit significantly more risk tolerance than non-economists, and 2) the age effect on risk tolerance does not differ significantly for economists.

Table 9 - Model (8) Heckman's selection model results

	Coef.	Std.	z	P>|z|
Age22	.0438753	.0702518	0.62	0.532
Age31	-.0080337	.0398241	-0.20	0.840
Age36	.103952	.0383159	2.71	0.007***
Age41	.0639327	.0389778	1.64	0.101
Age46	.1004978	.0378384	2.66	0.008***
Age51	.0887655	.0374182	2.37	0.018**
Age56	.0660506	.0377135	1.75	0.080*
Age61	.0933798	.0376915	2.48	0.013**
Economist	.0411076	.0854703	0.48	0.631
EconomistAge22	-.1339589	.2024769	-0.66	0.508
EconomistAge31	-.0623281	.1158759	-0.54	0.591
EconomistAge36	-.0970392	.1355795	-0.72	0.474
EconomistAge41	-.0248703	.1078751	-0.23	0.818
EconomistAge46	-.0846702	.1028705	-0.82	0.410
EconomistAge51	-.1022971	.106718	-0.96	0.338
EconomistAge56	-.0942874	.1070336	-0.88	0.378
EconomistAge61	-.0760914	.1162736	-0.65	0.513
ownHouse	.0247232	.023676	1.04	0.296
ExtraHouse	-.0238953	.0188087	-1.27	0.204
_cons	.4918598	.0603089	8.16	0.000***
Log pseudolikelihood = -2.38e+07				

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Conclusion

In this paper, we analyse whether economic or financial educational background affects individuals' financial risk tolerance. Hypothesizing that financial risk aversion may be influenced through channels such as financial literacy, analytical abilities, and overconfidence, we further investigate the potential drivers of risk tolerance.

Using observational data on households from the Survey of Income and Program Participation, we first find that households with a reference person who has an economics-related background tend to invest about 24 percentage points more of their liquid assets in stocks than households without such a reference person. The estimate, however, is statistically insignificant. We further find that age has a nonlinear effect on risk tolerance; initially, an increase in age is accompanied by an increase in risk tolerance, but after the age of 52, risk tolerance decreases as the investor approaches retirement. This pattern is consistent with previous findings and the conjecture that the age effect is initially driven by increasing stock market experience and at later stages by the decrease in remaining pay checks. We find that economists exhibit a similar pattern in risk tolerance with age, being the most risk tolerant around the age of 54.

We investigate if it is possible to spot any difference in the age pattern between economists and non-economists by constructing age dummies for each 5-year interval of the working age. We discover that non-economists appear to be somewhat risk tolerant initially, which is followed by an immediate decrease in risk tolerance. In the mid-30's, however, their risk tolerance again increases drastically and then fluctuates slightly around that level until retirement. We attribute the initially higher level of risk tolerance to overconfidence since the relative amount of liquid assets invested in stocks is reduced with age, suggesting that investors learn that their investment strategy is too aggressive as their stock market experience increases. Comparing this pattern to economists, we find that economists initially increase their risk tolerance in their 20's, while decreasing it again in their early 30's. After this point, however, their behaviour appears similar to that of non-economists, increasing their risk tolerance significantly during their mid-30's, after which it is decreased moderately as they approach retirement. Although this pattern is slightly different from that of non-economists, the differences between economists and non-economists are not statistically significant for any age group.

We analyse households where an economist is simply present rather than necessarily being the reference person, but find similar results.

As we suspect that economics education may influence risk tolerance through analytical abilities, we estimate the effect, controlling for households with individuals possessing a highly quantitative background. Again, we find that economists and non-economists appear to be similar, suggesting that analytical abilities are not very powerful in explaining risk tolerance.

Since the sample consists only of households with investments in stocks, we consider the possibility that the estimates suffer from selection bias. We apply a Heckman two-step estimator to obtain unbiased estimates, but do not find any notable differences in the results. We do, however, find that economists are more likely to participate in the stock market than non-economists.

We conclude that individuals with a background in economics and finance are not more risk tolerant with respect to investment behaviour than the average individual. Further, our results suggest that overconfidence, experience, and the number of remaining pay checks are more important in determining financial risk tolerance than financial literacy and analytical abilities.

Discussion

We will briefly discuss the design and findings of the study. We will start by comparing our findings to that of the literature reviewed has previously found, followed by a discussion of the policy implications raised by these findings.

We will wrap up the paper with a discussion of shortcomings and potential improvements in the study design as well as a section on proposals for further research that may contribute to the topic.

Comparison and contribution to literature

Whether relative risk aversion is constant or non-constant is quite inconclusive when referring to the literature. While Friend and Blume (1975) found it to be constant when excluding housing from the definition of total assets, others found it to be either increasing or decreasing. Arrow even emphasized that the results might be mixed despite initially proposing it as being constant (Durlauf and Blume, 2008). We find that income has no apparent effect on the ratio between risky and total liquid assets, thus implying CRRA, in line with Arrow's initial proposal and the findings of Friend and Blume (1975).

Additionally, we find that as one ages, they put a greater proportion of their assets into stocks, thus increasing their risk tolerance until around age 52 after which it decreases slightly. While this contradicts several studies, such as Friend and Blume (1975) and Morin and Suarez (1983), it is somewhat consistent with the findings of Riley and Chow (1992) who find that until the age of 65, risk aversion is decreasing, after which it increases.

Furthermore, we find that educational level does not impact risk tolerance when controlling for individuals holding a master's degree rather than a Bachelor's or Associate's degree. As literature finds somewhat mixed results with Jung (2015) finding that an additional year of schooling decreases risk tolerance for low levels of schooling in particular, this may indicate a nonlinear effect where the effect decreases in significance as the number of schooling years increases.

Economists are often found by previous studies to exhibit lower levels of risk aversion (e.g. Zhou, 2013). Explanations for this higher risk tolerance include lower perceived risk due to a greater level of financial literacy and analytical abilities (Bajo et al., 2015). Additionally, the literature finds that less experienced individuals with high financial literacy are more likely to be overconfident, thus also exhibiting lower risk aversion (Broihanne et al., 2014; Odean, 1998). Our study contributes to the existing literature on economists by using observational data to analyse if economists behave differently. Although our study is not able to confirm that economists exhibit lower levels of risk aversion due to financial literacy or analytical abilities, it does suggest that overconfidence, in fact, is prevalent in general amongst inexperienced investors.

Policy implications

The findings of this and previous studies indicate that economists to a larger extent participate in the stock market. Naturally, we would expect stock market participants to earn a higher return on their savings than non-participants. Thus, it is likely that financial literacy would be beneficial for the general public, as it could increase the participation rate of non-economists, which would, on average, reward them with higher returns.

Hence, including mandatory, or encouraging, economics education in schools would likely increase awareness of the stock market as well as financial literacy. This could ultimately increase participation rates for the general public, leaving those who do not actively choose an economics education better off.

Due to the complexity of some economics topics, we suggest that economics education is saved for high school, increasing the likelihood that more students pick up the content of the courses. More simple topics on private economics might also be introduced at middle school levels to create awareness of economics topics at a relatively early age, potentially increasing financial literacy further in the general public.

Personal finances are an important part of people's everyday lives, and earning a proper return on savings is relevant to increasing their well-being, especially after retirement. Therefore, strengthening financial abilities even for those who are not necessarily interested in an economics or finance education is of great importance, as many are likely to fail in accumulating a large long-run return on their savings otherwise.

Shortcomings of the study

Although this study attempts to correct for some of the issues faced when analyzing differences in risk aversion between economists and non-economists, a number of shortcomings still persist to influence the results and conclusions of this paper due to the limits of the data.

Ideally, such a study would have made use of panel data to analyze the age effect of risk aversion. The fact that the study uses cross-sectional data indicates that we do not, in fact, follow individuals' decisions over time. Since the individuals of different age groups belong to different generations, they might differ with respect to some underlying variable. For instance, it has been found that individuals who experience extreme macroeconomic conditions such as the great depression of the 1930s or the financial crisis of 2008 may become more risk-averse. For our study, this could imply that the individuals of the lowest age group were inherently less risk-averse as they might not have been investing at all in 2008 when the markets dropped.

Additionally, problems can appear when working with household data rather than individual data. This study suffers from not necessarily having assigned individuals to ages correctly. As the age of the reference person of each household has been used for all subjects of the household, some economists may have been placed in the wrong age group if they were not the reference person of their household. Likewise, some non-economists may have been placed in the wrong age group if they were not the reference person of their household. This problem is, however, limited in scale as long as the individuals in the household do not differ too much in age. As we would expect that the relevant individuals of the household typically are married and close in age, they would often end up in either the same or an adjacent age category anyway. More problematically, household data also causes the problem that other personal factors that may influence both educational choice and risk aversion, such as gender and marital status, cannot be controlled for.

The study relies on a number on assumptions regarding the proxies used. Since occupation is used as a proxy for education, one crucial assumption is that most people with an associate's degree or higher end up working within the same field as their education. Whether this holds true is questionable. Although people are generally expected to choose a major in the field they wish to be occupied in, large financial institutions often choose employees based on intelligence and productivity signals rather than field of education (Ho, 2009). This is especially expected to be the case in the United States where the norm is to hold a bachelor's degree, at which point the student has not necessarily been taught advanced concepts yet anyway. If this trend is sufficiently significant, finding any difference between the economists and non-economists would be practically impossible.

In studying the quants, an assumption is further made that having taking an education in a quantitative field and having a high level of analytical abilities are highly correlated. Although some self-selection is to be expected, other possibilities can also be thought of. For instance, literature finds that risk-averse individuals may also self-select into engineering and natural sciences due to the certainty associated with jobs in these fields. Other possible scenarios could include utility-maximizing individuals with strong preferences for wealth choosing some of these fields due to the expected return, or related, that individuals may also choose such majors merely to signal intelligence. In such cases, we would not necessarily expect these fields to be dominated by individuals with high analytical abilities, but rather by individuals who have made informed decisions.

The most significant drawback of the study relates to the complexity of measuring risk aversion. Since risk aversion is a function of many other personal factors such as experiences and perception, and individuals do not even always behave in consistency with their own rules, as behavioural theory suggests, measuring risk aversion precisely using stock market data can be a difficult task. As the measure we have applied for risk tolerance is simply the ratio of risky assets held to total liquid financial assets owned, the measure may not even evaluate the individuals' risk aversion properly.

Further research

There are several ways in which one may change the design of the study to capture some effects that this study failed to do.

This study was conducted using cross-sectional data. The same study could, ideally, be conducted as a panel study, thus controlling for changes in behaviour across generations. One may use other panels of SIPP or other studies such as the Longitudal Study of American Youth (LSAY). However, relying on the same persons in the dataset over time will, for now, leave the researcher with a relatively limited amount of observations.

One of the biggest challenges of this study was to estimate educational background, and occupation may not fully reflect the educational background that the household residents have. Especially an area such as economics is one that may be occupied by individuals with other educational backgrounds. Thus, it would be ideal to have the actual educational background rather than a proxy, yet this is a measure which most public datasets cease to provide. Thus, in this case, one may choose to use primary data for the study in order to obtain all relevant data. More sophisticated researchers might also have access to more comprehensive data sets and would thus have the opportunity to investigate a similar problem with higher precision.

This paper further investigated liquid assets of households, thus ignoring e.g. pension savings. One might study how individuals or households choose to invest their pension savings to analyse whether economists differ in their portfolio construction. Further, the study may be expanded to include other types of risk tolerance as well.

In general, conducting studies on people's investment behaviour is no simple task, and conducting a sufficiently satisfying study often proves challenging due to the vast amount of observational as well as behavioural characteristics that affect investment behaviour.

Finally, a natural extension of this study would be to analyse whether economists actually do get higher returns in the stock market than non-economists.

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Appendix

Appendix 1

Appendix 1A – Financial and economic occupation

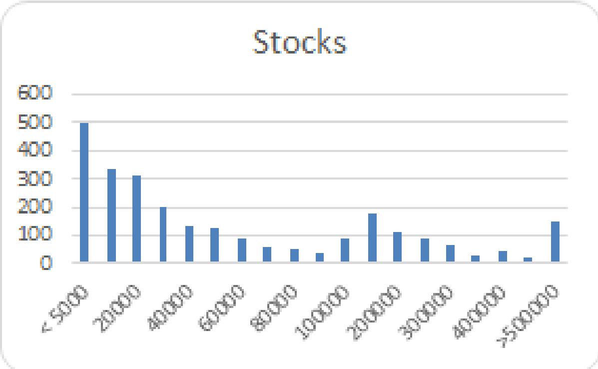
Financial managers
Accountants and auditors
Appraisers and assessors of real estate
Budget analysts
Credit analysts
Financial analysts
Personal financial advisors
Insurance underwriters
Financial examiners
Loan counselors and officers
Tax examiners, collectors, and revenue agents
Tax preparers
Financial specialists, all other
Economists
Insurance sales agents
Securities, commodities, and financial services sales agents
Real estate brokers and sales agents
Bookkeeping, accounting, and auditing clerks
Tellers
Brokerage clerks
Credit authorizers, checkers, and clerks
Loan interviewers and clerks
New accounts clerks

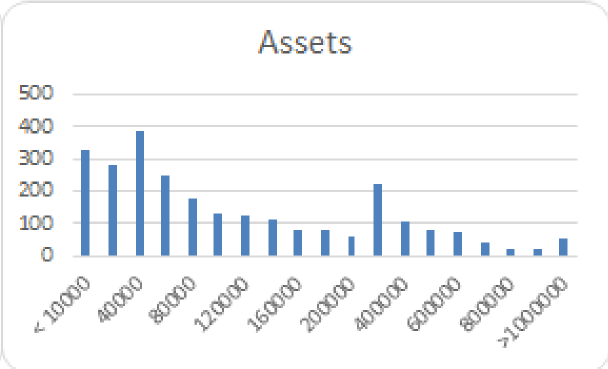
Appendix 1B - Quantitative occupations

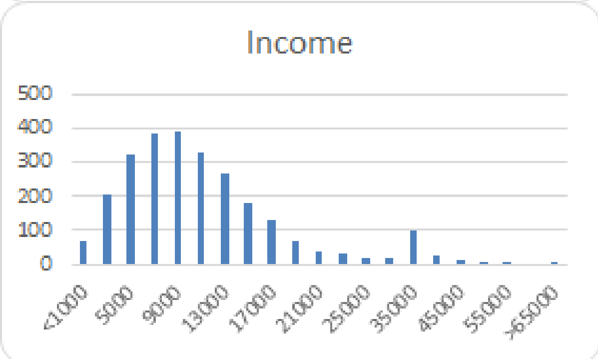
Engineering managers
Computer scientists and systems analysts
Computer programmers
Computer software engineers
Computer support specialists
Database administrators
Network and computer systems administrators
Network systems and data communications analysts
Actuaries
Mathematicians
Statisticians
Miscellaneous mathematical science occupations
Aerospace engineers
Agricultural engineers
Biomedical engineers
Chemical engineers
Civil engineers
Computer hardware engineers
Electrical and electronic engineers
Environmental engineers
Industrial engineers, including health and safety
Marine engineers and naval architects
Materials engineers
Mechanical engineers
Mining and geological engineers, including mining safety engineers
Nuclear engineers
Petroleum engineers
Engineers, all other
Astronomers and physicists
Atmospheric and space scientists
Chemists and materials scientists
Environmental scientists and geoscientists
Physical scientists, all other

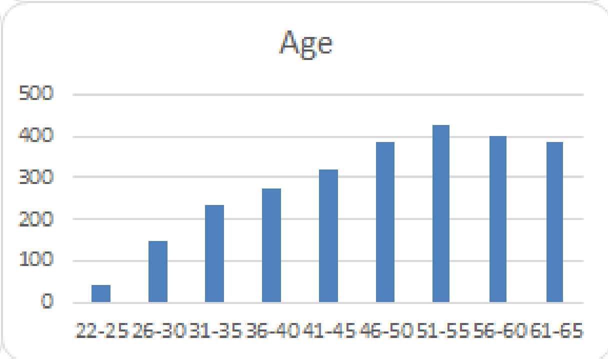
Appendix 2

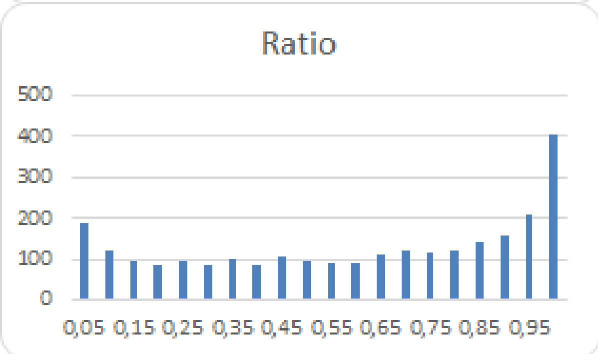
Variable distributions - Full sample











Variable distributions – Economist

Variable distributions – hasEconomist